## Final Report

# ANALYSIS OF TRUCK DRIVERS' OPINIONS ON SAFETY AND TRAFFIC CONTROL ON HIGHWAY WORK ZONES <br> Volume II 

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The contents of this report reflect the views of the authors who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Illinois Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

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## CHAPTER 1

## INTRODUCTION

The fatal accident rate of semi-trucks in Illinois in 1992 (accidents per 100 million vehicle miles traveled over all highway types) was 2.28 , but for all vehicles it was 1.42 . The fatal accident rate of semi-trucks was 1.61 times higher than that of the other vehicles. On the other hand, the ratio for total crashes was 0.75 and for injury crashes it was 0.58 . The ratios indicate that in terms of vehicle miles traveled (VMT) the semi-trucks are under- represented in the total and injury crashes, but are over-represented in fatal crashes. Accurate data are not readily available to compute the ratios for work zones, but it is reasonable to assume that work zone accidents would present a similar trend. Considering that the trucks travel about ten times more miles than cars, reducing the frequency, as well as the severity, of truck accidents would improve work zone safety for all motorists.

There were 9,949 work zone crashes in Illinois in 1992, of which 29 were fatal and 2,422 were injury type [1]. Since 1988, the number of injury and total crashes have steadily increased, while the number of fatal accidents has not shown a clear trend (see Figure 1.1). The work zone accident frequencies in terms of VMT or another suitable exposure rates are not known. Without such exposure rates meaningful comparisons of work zone safety is not possible.

Accident records are very helpful in evaluating past performances, however they contain very little information about the emerging problems, those that are not reflected in the accident records yet, and problems that are not directly represented in the accident record (such as "near miss" accidents). Furthermore, the locations of the accidents in work zones are not accurately coded in most of the accident files, so an in-depth work zone accident study has not been conducted. There are a limited number of studies about location of accidents in the work zones, but they did not identify where "near miss" type accidents, bad driving situations, or difficult driving situations take place in work zones.

This study was conducted to determine the truck drivers' travel characteristics, concerns about work zone traffic control devices, assessment of work zone features, as well as to determine the location of accidents and bad driving situations based on the experiences and perceptions of truck drivers. The term bad driving situations (BDS) is used because during pretesting of the questionnaire we realized that truck drivers were using it to describe a difficult driving situation, a "near miss" accident situation, an unsafe driving situation, or situations with a higher risk of accidents.

A statewide survey of semi-truck drivers was conducted in 6 locations in Illinois. The questionnaire contained 43 questions about truck drivers and travel characteristics, drivers'

Figure 1.1 Work Zone Accidents in Illinois

> Note: Unit of total and injury accidents is 1,000 accidents.
> Source: "Illinois Crash Facts and Statistics 1992," Division of Traffic Safety, Illinois DOT.
assessment of work zone features and traffic control devices, their accident and bad driving situation experiences, and their suggestions for improving traffic flow and safety in the work zones. About 930 truck drivers participated in the survey, and the responses from 834 of them were found suitable for further data analysis.

The frequency of the responses to each question were analyzed. Also correlation analyses were conducted to identify the relationships among the surveyed questions. Different statistical tests such as the test of significance of correlation coefficients, the $F$-test, ANOVA, and the $\chi^{2}$ goodness-of-fit test were used for data analysis.

A short report entitled "Analysis of Truck Drivers' Opinions on Safety and Traffic Control on Highway Work Zones, Volume I, Summary of Findings," which contains the summary of findings, conclusions, and recommendations of this study is also prepared. The readers who are more interested in the findings of the study than the details of data analysis may read the summary report. This report includes all of the information that is included in Volume I of this report.

## CHAPTER 2

## LITERATURE REVIEW

In 1993, there were 53,717 vehicles involved in fatal crashes, which resulted in 40,115 traffic fatalities in the US. About 4320 large trucks (gross vehicle weight over 10,000 pounds) were involved in fatal accidents that resulted in 4,849 fatalities. In 1993 in Illinois, 1,903 vehicles were involved in fatal crashes, of which 153 were large trucks [2,3]. Three percent of all registered vehicles are large trucks and they account for $7 \%$ of vehicle miles traveled, however they are involved in $8 \%$ of fatal crashes [3].

For large trucks, the fatal accident rate (the number of accidents per 100 million VMT) is higher but the property-damage-only (PDO) and injury type accident rates are lower compared to the rates for passenger cars [2]. Over the years, the fatal accident rate for large trucks has been consistently higher than the rate for passenger cars (see Figure 2.1). In 1992, the fatal accident rate was 1.9 for passenger cars and 2.6 for large trucks. On the other hand, in 1992 for passenger cars the PDO and injury rates were 304 and 265, but the rates were 182 and 62 for large trucks, respectively.

In fatal crashes involving large trucks, the victims often are not the occupants of the large trucks. Nationally, in fatal crashes involving large trucks only $13 \%$ of the fatalities were the large truck occupant. For Illinois the percentage is $16 \%$ (see Figure 2.2). Furthermore, large trucks fatality rate on rural highways is much greater than urban highways. For example, in Illinois, only $16.4 \%$ of the tractor-trailer crashes took place in rural locations, but they accounted for $52.2 \%$ of the fatalities in 1992 [1].

Accident involvement rate may vary by several factors. Meyers [4] compared truck and passenger-car accident rates, for 1976 through 1978, on 34 limited-access facilities ( 21 toll expressways and turnpikes, 13 bridges and tunnels). He found that the fatal, injury and overall expressway accident rates for heavy trucks exceeded that of the passenger cars; for the bridges and tunnels, overall accident rates for heavy trucks were four times greater than that for the average passenger car. However, his approach and findings were questioned by other authors [4].

Mçee [5] suggested that the key variables that influence truck safety might include truck type, truck length, truck trailer type, truck weight, driver type, driver age, and highway type. Garber and Joshua [6] found that the driver-related factors were mostly responsible for largetruck crashes: $75 \%$ of all large-truck crashes and $91 \%$ of large-truck fatal crashes on Virginia highways. In large-truck fatal accidents, driver error was associated with over $50 \%$, speeding accounted for $21 \%$, and alcohol for 15 percent.

Lyles et al. [7] reported that the most significant factor associated with truck accidents
in Michigan was the roadway class (highest rate on local roads and lowest rate on limited-access roads). Urban accident rates were lower than rural rates, and younger drivers were involved in more accidents than the average.

Hall and Lorenz [8] found that the number and rate of accidents increased during construction in New Mexico. The total number of accidents during the construction period increased by $26 \%$ for all highways. The increase was $33 \%$ for rural Interstate, $17 \%$ for rural Federal-Aid Primary (FAP), and $25 \%$ for rural Federal-Aid Secondafy (FAS) highways. The proportion of rear-end accidents increased from $9 \%$ in the before-construction period to $14 \%$ during the construction period.

Nemeth et al. [9] studied Ohio Turnpike work zone accident characteristics and found that $52 \%$ of construction zone accidents were "hitting objects" type compared to $38 \%$ for all Turnpike accidents. They found that there was a high accident rate at crossovers, especially at night. Truck accidents at crossovers was $75 \%$ of the total accidents at crossovers, while truck accidents at other work zone areas was $52 \%$ of the total accidents, indicating that the driving task was more demanding here than at other work-site zones or on highways in general.

To study the relationship between truck accidents on rural interstate highway and geometric design, Miaou et al. [10] used Poisson regression approach and found that ADT, horizontal curvature, and vertical curvature were significantly related to accident involvement. Abkowitz [11] reviewed the available data bases and concluded that the ability to conduct reliable studies of heavy truck safety is significantly hampered by the deficiencies in the existing data bases.

Glauz and Harwood [12] reviewed a study by Vallette et al. [13] which found that the accident involvement rates of double trailer trucks was higher than single-trailed trucks. Glauz and Harwood concluded that the Vallette's conclusions were not supported by the data bases. Polus and Mahalel [14] found for trucks the total accident involvement rates were lower, but the fatal accident rates were higher than those of passenger cars. They also found that trucks were more involved in front-rear, side, and single-vehicle type of accidents compared to passenger cars.

ITE Technical Council Committee [15] reported on truck effects on geometric design elements and safety. Among the factors mentioned were: turning radii and offtracking, reverse curve crossovers, downgrade with lane restriction to one lane, temporary barriers located where they are likely to be struck at high speeds and angles, short merging and exit ramp distances, and lack of provision of the same geometric standards as the adjacent road through a detour construction area. Some of these factors may be encountered in construction zones and, therefore, truck drivers may have more difficulties to negotiate such geometric features.

Rouphail and Jovanis [16] investigated the accident and accident reporting system in Illinois and concluded that the accident coding system was not adequate for identification of

Figure 2.1 Fatal Accident Involvement Rate in U.S.


Source:
"Traffic Safety Facts 1993," National Highway Traffic Safety Administration, U.S. DOT.
Figure 2.2 Fatalities in Crashes Involving Large Trucks


Sources:
"Traffic Safety Facts 1993: Large Trucks," National Highway Traffic Safety Admin., U.S. DOT.
"1992 Illinois Crash Facts and Statistics," Division of Traffic Safety, Illinois DOT.
construction zone accidents. They used the data for the interstate highways in the Chicago area. For long-term (over 4 days) lane closure sites, on the average, $50 \%$ of accidents known to have happened during the construction period could be identified as such from accident data. This number was about $10 \%$ for non-lane closure sites and/or sites with intermittent construction activities. They found that for the long-term lane closure site the accident rate, rear-end accident, and multiple vehicle accident increased, but accident severity decreased. They also compared the results of a case study to the results from the historical data base and confirmed that the accident severity decreased and rear-end accidents increased in construction zones. For the case study the proportion of fatal and injury accidents was $20 \%$ vs $24 \%$ for the Chicago area expressway system and rear-end accidents were $52 \%$ vs $43 \%$ for the area. Semi-trailer involvement was $14 \%$ of all involvements vs $8 \%$ for the area.

## CHAPTER 3

## STUDY APPROACH

The overall study approach is to develop a questionnaire, to conduct a state-wide survey of semitruck drivers, to perform statistical analyses to examine travel characteristics and the relationships among responses, and to interpret the findings of the study.

## Survey Instrument

A survey instrument was developed in collaboration with the Illinois Department of Transportation (IDOT). The questionnaire contained 43 questions about drivers and vehicles characteristics, drivers' assessment of work zones and the traffic control devices, their accident and difficult driving experiences, and their suggestions for improving traffic flow and safety in the work zones. The subjects included in the survey are listed in Table 3.1, and a copy of the actual questionnaire is given in Appendix A.

## Pre-Testing

The questionnaire was pre-tested using about 100 truck drivers. The data collection procedures for the pre-test followed, as closely as possible, those planned for the main survey in order to provide a thorough test of the survey procedures and questionnaire. The returned questionnaires were closely examined to determine if there were any unforeseen problems. Their input was used for minor revisions and clarification of the questions or responses. The term "bad driving situations" came out of this pre-testing.

## Data Collection

The main surveys were conducted from $9 \mathrm{am}-5 \mathrm{pm}$ on weekdays in September and October of 1993. The survey questionnaires were handed to the truck drivers (excluding pickups) and were collected after they were completed. The purpose of the survey was also explained to the drivers and they were assured that their responses would not affect their personal records. Most of the data were collected at truck stops and a small number at a rest area. Approximately one out of four drivers refused to answer the questionnaire. There was not a common characteristics among those who refused to participate, thus they would not cause a bias in this study. It seems that these drivers were tired or were in a hurry. In general, the response rates at rest areas were lower than those at truck stops. A total of 930 truck drivers were interviewed.

Table 3.1 Survey Items in Questionnaire

| Number | Description |
| :---: | :--- |
| 1 | Driving experience (in year) |
| 2 a | VMT during last year in U.S. |
| 2 b | VMT during last year in Illinois |
| 3 | Driver age |
| 4 a | Type of current truck |
| 4 b | Type of current carrier |
| 4 c | Number of trucks in current caririer |
| 5 | Preferred time of day to drive |
| 6 | Type of permits for current truck |
| 7 | Preferred distance of adivanced signs about work zones (miles) |
| 8 | Perceived hazard of driving through work zones |
| 9 | Preferred type of work zones: median crossover yersus one-lane closure |
| 10 (A-I) | Nine items about driving situations and work zones conditions(merging, |
|  | crossover, lack of shoulder, edge drop off, loose materials, dirt and dust, |
|  | lane width, "S" curves, and taper length |
| 11 a | Opinion about speed limit of 55 mph in work zones |
| 11 b | Actual speed in work zones with 45 mph speed limit |
| 12 | Locations the driver experienced bad driving situations in work zones |
| 13 | Locations of accidents in work zones |
| 14 a | Visibility of flaggers |
| 14 b | Directions given by flaggers |
| $15(\mathrm{~A}-\mathrm{G})$ | Seven items about traffic control devices (cones, barricades, plastic |
|  | barricades, barriers, barrels, tubes, and impact attenuators) |
| 16 a | Height of arrow boards |
| 16 b | Brightness of arrow boards |
| 17 a | Height of CMB |
| 17 b | Brightness of CMB |
| 18 | Unclear or confusing signs in Illinois work zones (if any, specify) |
| 19 | Need to add more signs or messages in the work zones (if any, specify) |
| 20 | Driving in Illinois work zone(s) today |
| 21 | Suggestions |
| 22 | Comments |
| Total | 43 questions |
|  |  |

The data collection sites were selected such that near every data collection site there was at least one construction zone. Figure 3.1 shows the data collection sites and adjacent construction zones. Data were collected in the areas of Danville (I-74), Bloomington (I-74), Morton (I-74), Springfield (I-55), Chicago (I-80) and Effingham (I-57) in Illinois. The number of surveys conducted at each site is given in Table 3.2. These locations were spread over entire state and is believed to represent the truck drivers on Illinois Interstate Highways. Almost all of the surveyed drivers ( $94 \%$ ) had driven through work zone(s) the day of the survey.

## Data Reduction

The questionnaire had tbree categories of quastions: personal information questions ( 1 thru 4c), traffic operations and safety related questions (5 thru 19); and open-ended and other questions (20 thru 22). In order to increase consistency and accuracy, the following steps were taken in data reduction:

## Checking Unanswered Questions

Responses which have large portion of unanswered questions were deleted, such as:

- Those who did not answer the last page of the questionnaire
- Those who did not answer more than 10 sub-questions in questions 10 and 15
- $\quad$ Those who did not answer more than one third of traffic engineering part (questions from 5 to 19)
- Those who did not answer equal to or more than 10 questions of the questionnaire About $8 \%$ of the surveyed sample were deleted by checking unanswered questions. This decision reduced the available sample to 857 .


## Checking Consistency

- Those who had inconsistencies in questions 1 and 3 , and questions 2 a and 2 b were deleted. It is assumed that question 1 (driving experience) should not represent unreasonably high values compared to question 3 (age of driver). For example, drivers who were under age 40 and said they have had 26 or more years truck driving experience were deleted from the sample. Also question 2 b (miles driven in Illinois) should not represent unreasonably high values compared to question 2 a (miles driven in U.S.).
Those who said that they drove 300,000 or more miles last year were deleted.
About $2 \%$ of the available sample (857) were deleted by checking inconsistency in answered questions. This reduced the sample size to 834 . Thus, the statistical analyses were performed based on the final sample size of 834 .

In addition to the data reduction process, when a driver selected one or more answers for a question, we analyzed the answers to see if a logical choice could be made based on other

Table 3.2 Survey Site, Date, and Size

| Location | Date | Number of Surveys |
| :---: | :---: | :---: |
| $\begin{aligned} & \text { DANVILLE - I-74 } \\ & \text { OAKWOOD } \\ & \text { POTOMAC } \end{aligned}$ | $\begin{aligned} & 09.13 .93 \\ & 09.14 .93 \\ & 09.23 .93 \\ & 09.30 .93 \end{aligned}$ | 100 38 42 19 total: 199 |
| $\frac{\text { BLOOMINGTON I-74 }}{76 \text { TRUCK STOP }}$ | $\begin{aligned} & 09.16 .93 \\ & 09.24 .93 \\ & 09.30 .93 \end{aligned}$ | $\begin{gathered} 110 \\ 68 \\ 25 \\ \text { total: } 203 \end{gathered}$ |
| $\frac{\text { MORTON } \mathrm{I}-74}{\text { GRIMM'S }}$ | $\begin{aligned} & 09.15 .93 \\ & 09.24 .93 \\ & 09.28 .93 \\ & 09.30 .93 \\ & 10.05 .93 \end{aligned}$ | 44 56 44 13 41 total: 198 |
| $\frac{\text { SPRINGFIELD } \quad \text { I-55 }}{\text { NEVILL'S }}$ | $\begin{aligned} & 09.21 .93 \\ & 09.24 .93 \\ & 10.01 .93 \end{aligned}$ | $\begin{gathered} 50 \\ 77 \\ 65 \\ \text { total: } 192 \end{gathered}$ |
| $\frac{\text { CHICAGO (Joliet) I-80 }}{\text { R-PLACE }}$ | 09.28 .93 | $\begin{gathered} 65 \\ \text { total: } 65 \end{gathered}$ |
| $\frac{\text { EFFINGHAM } I-57}{\text { EFFINGHAM }}$ | 09.29 .93 | $\begin{gathered} 73 \\ \text { total: } 73 \end{gathered}$ |
| TOTAL |  | 930 |

Figure 3.1 Map of Survey Sites and Work Zones

answers. The followings are examples:

- $\quad 16$ drivers said that they drove below 45 and at 45 mph (Question 16). They were coded "at 45 mph " because it followed the "below 45 mph " response.
- $\quad 38$ drivers selected more than one truck type indicating that they drove more than one type of truck last year. One of the selected truck types was randomly assigned to these drivers. These are the drivers whose choices did not follow a clear pattern (e.g., tanker and chemical).


## Data Analysis

First, the frequency distribution for each item of the survey was examined. The frequency distributions are given in Appendix B. Then, different statistical tests were conducted, based on the distribution characteristics of the responses, as well as on the number of groups to be compared (see Table 3.3). It should be noted that the frequencies reported in Appendix B are the "raw" frequencies. For statistical analyses further data editing and/or re-grouping were performed on these raw frequencies. For continuous variables the analysis of variance (ANOVA) was applied, and for the discrete variables, comparisons were made using $\chi^{2}$ goodness-of-fit tests. All statistical tests were performed, unless otherwise stated, with a $90 \%$ confidence level.

The GLM (general linear model) procedure in SAS was used for the ANOVA because of unbalanced situations [17]. An unbalanced situation is when there are unequal number of observations for different combinations of class variables, which is the case in this survey. SAS recommends, in this situation, to use the GLM procedure instead of the ANOVA procedure. For continuous variables the GLM results will show whether or not the average values for all groups are the same or whether there is at least two groups with different mean values. We looked at the $F$ values in the GLM output to make such judgments. If $F$ values showed that they were significantly different, we looked at the results of Duncan's Multiple Range Test to see which groups are different. In the case of two groups, $t$-test also can be used to find out the mean difference of two groups.

For the discrete variables, $\chi^{2}$ goodness-of-fit tests were used. Drivers were grouped into several (two or more) categories based on responses of question items. Each group was further divided into various travel characteristic sub-groups. The test was used to see if certain drivers were over- or under-represented. These tests would identify if an unexpected number of drivers have certain characteristics. In these tests, SAS recommends that no more than $20 \%$ of the cells should have expected values less than 5 if the degree of freedom is greater than 1 [17]. When the original classification of each item in the questionnaire was not suitable for these tests, each items were re-classified. The final classification is shown in Table 3.4.

TABLE 3.3 Tests used in correlation analyses of various questions

| : | $\begin{aligned} & \text { Q. } 1 \\ & \text { Q. } 2 \mathrm{a}-\mathrm{b} \\ & \text { Q. } 3 \end{aligned}$ | Q.4a-b | Q.4c | $\begin{aligned} & \text { Q. } 5 \\ & \text { Q. } 6 \\ & \text { Q. } 7 \\ & \text { Q. } 8 \\ & \text { Q. } 9 \end{aligned}$ | Q. 10 | $\begin{aligned} & \text { Q.11a- } \\ & b \\ & \text { Q. } 12 \\ & \text { Q. } 13 \\ & \text { Q. } 14 \mathrm{a}- \\ & \mathrm{b} \end{aligned}$ | Q. 15 | $\begin{aligned} & \text { Q. } 16 \mathrm{a}-\mathrm{b} \\ & \text { Q. } 17 \mathrm{a}-\mathrm{b} \\ & \text { Q. } 18 \\ & \text { Q. } 19 \\ & \text { Q. } 20 \\ & \text { Q. } 21 \\ & \text { Q. } 22 \\ & \hline \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { Q. } 1 \\ & \text { Q. } 2 \mathrm{a}-\mathrm{b} \\ & \text { Q. } 3 \end{aligned}$ | A | B | A | B | B | B | B | B |
| Q.4a-b | B | C | B | C | C | C | C | C |
| Q.4c | A | B | - | B | B | B | B | B |
| $\begin{aligned} & \mathrm{Q} .5 \\ & \mathrm{Q} .6 \\ & \mathrm{Q} .7 \\ & \mathrm{Q} .8 \\ & \mathrm{Q} .9 \\ & \hline \end{aligned}$ | B | C | B | C | C | C | C | C |
| Q. 10 | B | C | B | C | C | C | C | C |
| $\begin{aligned} & \text { Q. } 11 \mathrm{a}-\mathrm{b} \\ & \text { Q. } 12 \\ & \text { Q. } 13 \\ & \text { Q. } 14 \mathrm{a}-\mathrm{b} \end{aligned}$ | B | C | B | C | C | C | C | C |
| Q. 15 | B | C | B | C | C | C | C | C |
| $\begin{aligned} & \text { Q.16a-b } \\ & \text { Q. } 17 \mathrm{a}-\mathrm{b} \\ & \text { Q. } 18 \\ & \text { Q. } 19 \\ & \text { Q. } 20 \\ & \text { Q. } 21 \\ & \text { Q. } 22 \end{aligned}$ | B | C | B | C | C | C | C | C |

Note: A (continuous/continuous; test of significance of r - correlation coefficient)
B (continuous/discrete; F-test)
C (discrete/discrete; $\chi^{2}$ goodness-of-fit test)

Table 3.4 Classification of Each Items in Questionnaire

| Question | Classification |
| :--- | :--- |
| Q.1 | Same as in the questionnaire |
| Q.2a | $"$ |
| Q.2b | $"$ |
| Q.3 | $"$ |
| Q.4a | 5 groups (A, C, E + K, F+G, B $+\mathrm{D}+\mathrm{H}+\mathrm{I}+\mathrm{J}$ ), ignore L |
| Q.4b | 3 groups (A, B, C), ignore D, E and multiple-answers |
| Q.4c | Same as in the questionnaire |
| Q.5 | 2 groups (A, C), delete B |
| Q.6 | 3 groups ("no", "over-dim", "hazmat"), ignore "both" (combination |
| of "over-dim" and "hazmat") and F |  |$|$| Q. 7 |
| :--- |

## CHAPTER 4

## TRAVEL CHARACTERISTICS OF TRUCK DRIVERS

The frequency of responses to various questions are summarized in Tables 4.1-4.3 (see the end of this chapter). It should be noted that these frequencies may be slightly different than the "raw" frequencies reported in Appendix B. The difference is due to data editing and/or regrouping that was done to prepare the data for statistical analyses. These results will be discussed in the following sections.

## Experience and Age

The participants' truck driving experience varied from 0 to 48 years with an average value of 16.1 years. Figure 4.1 shows the distribution of driving experience of the sample. There were about $11 \%$ with more than 30 years and about $8 \%$ with 2 years or less of driving experience. Their average age was 43 years old and the range was from 20 to 68 years old. Approximately $60 \%$ of the sample were within a range from 31 to 50 years old (see Figure 4.2 a ). The 61 years old and above represented $2.5 \%$ while the 25 years old and below represented $4.3 \%$ of the sample. There was a relatively strong correlation between the driver age and driving experience. The cross classification of age versus truck driving experience is shown in Figure 4.2 b . This figure show a logical relationship between the two variables. For example the driver's age is , in general, greater than the years of experience plus the minimum age for driving a truck. Also, a correlation analysis between the age and experience supported this relationship.

## Miles Driven

The truck drivers were asked to indicate the total number of miles they drove last year and what portion of that was in Illinois. To increase the accuracy, only those drivers with one full year of driving experience were considered in the analysis. The average total miles driven was 112,000 and the range was from 0 to 290,000 miles (see Figure 4.3). About $68.8 \%$ of them drove between 90,000 and 150,000 miles. About $9.8 \%$ of the sample drove 50,000 miles or less, and about $3.9 \%$ drove over 190,000 miles per year. Values higher than 290,000 miles were deleted from the analysis since driving more than 290,000 miles in one year appears to be unreasonable.

The drivers response to the miles driven just in Illinois indicated that the average was 25,000 miles and the range was from 0 to 250,000 miles per year. It was observed that $36.4 \%$

Figure 4.1 Frequency of Driving Experience


Figure 4.2a. Frequency of Age


Figure 4.2b. Frequency of Age and Driving Experience


```
Driving Experience (Years)
```




Figure 4.3 Frequency of Miles Driven in USA

drive less than 10,000 miles (see Figure 4.4). The miles driven in US were not correlated to the miles driven in Illinois.

## Trucks and Carrier Types

The drivers were asked to indicate what types of trucks they were driving. Figure 4.5 shows that the box van was the most cited ( $55 \%$ ) type of truck, followed by flatbed/platform ( $13 \%$ ), tanker/hopper ( $7 \%$ ), and the double-bottom ( $7 \%$ ) types. Common carrier was the largest carrier type ( $62 \%$ ) which drivers worked for, followed by contract ( $18 \%$ ), private ( $12 \%$ ), and others ( $8 \%$ ). The average number of trucks per company was approximately 930 trucks and the range was from 1 to 25,000 trucks (see Figure 4.6). The survey included drivers working for small as well as large companies. About $12 \%$ and $22 \%$ of the drivers said their companies have not more than 10 and 20 trucks, respectively.

## Travel Time and Load Permit

About $88 \%$ of the drivers answered that they had driven their trucks all hours which is somehow expected due to the needs of their profession (i.e., schedules, nature of loads, etc.). About $10 \%$ said that they usually drive daytime, and only $2 \%$ said that they usually drive nighttime.

Drivers were asked if they were carrying any type of permit at the survey time. About $79 \%$ said that they were not holding any type of permit. About $15 \%$ said they were carrying hazardous material related permits, and $5 \%$ said they had over-dimension permits ( $5 \%$ ). About $1 \%$ said they had both hazardous materials and over-dimension permits.

## Advanced Warning of Work Zones

Truck drivers want to know far in advance about the presence of work zones. Approximately half of the sample ( $47 \%$ ) said that work zones sign should be posted 3-5 miles ahead, followed by $1-2$ miles ahead ( $34 \%$ ), $6-10$ miles ahead ( $14 \%$ ). Only $5 \%$ said that it should be posted less than 1 mile or more than 10 miles ahead.

## Hazard of Driving through Work Zones

Drivers were asked to compare the hazard of driving through work zones to non-work zones. A large majority of truck drivers ( $90 \%$ ) answered that traveling through work zones are more hazardous than non-work zone areas (see Figure 4.7). This is very high compared to the findings of a previous study $[18,19]$ in which $54 \%$ of drivers (all drivers not just truck drivers)

Figure 4.4 Frequency of Miles Driven in Illinois


Figure 4.5 Frequency of Truck Type


Notes: BOX(box van), DUMP(dump), DBOT(double bottom), POLE(pole) TANK(tanker/hopper), FLAT(flatbed/platform), LOW(lowboy), GRAIN(grain) LIVE(livestock), AUTO(auto-transport), CHEM(chemical), OTH(others)

Figure 4.6 Frequency of Number of Trucks Operated in a Company


Figure 4.7 Hazard Assessment of Work Zones Compared to Non-Work Zones

said the work zones were not more hazardous. It is interesting to note that, in the previous study only $16 \%$ of the respondents were driving large trucks compared to this survey which includes only the drivers of large trucks. This indicates that an educational effort to increase drivers perception of hazard in the work zones should mainly be directed toward car drivers to increase their perception of hazard in work zones.

## Work Zone Layout Preferred

Drivers were given sketches of a work zone with one-lane closure and another one with median crossover, and were asked to indicate their preferred configuration. The percentage of those drivers who preferred the median crossover were only slightly higher than that of one-lane closure (see Figure 4.8a). About $29 \%$ said that they have no preference. These responses indicate that truck drivers do not have a preferred work zone configuration. The cross classification of work zone configuration and truck types is given in Figure 4.8b. A highier percentage of box van drivers seems to prefer the median cross over, and a higher percentage of tanker seems to prefer the one lane closure layout:

## Work Zone Features

Drivers were asked to indicate if any of the listed work zone features make them uncomfortable when they drive through work zones. The listed work zone features in the questionnaire are: merging to an open lane, median crossovers, lack of shoulders, pavement edge dropoff, loose construction materials on open lane, blowing dirt or dust, lane width, driving in "S" curves, and lane closure taper length. Truck drivers' feelings about these work zone features are classified as follows: "it does not make me uncomfortable," "it makes me uncomfortable sometimes," and "it makes me uncomfortable most of the times," and "no opinion." The frequencies of responses are summarized in Table 4.2.

Pavement edge dropoff, loose construction materials on an open lane, lack of shoulder, and lane width made $62 \%, 57 \%, 53 \%$, and $45 \%$, respectively, of drivers uncomfortable most of the times. Blowing dirt and dust made about $1 / 3$ of truck drivers uncomfortable most of the time. Merging to an open lane, driving in "S" curves, lane closure taper length, and median crossovers made $18-22 \%$ of the drivers uncomfortable most of the time.

Combining the responses to the "most-of-the-times" with the "sometimes" categories indicated that any one of these work zone features made at least half of the drivers feel uncomfortable when driving through work zones. As an example, pavement edge dropoff, loose construction materials, lack of shoulders, and lane width made $85 \%$ or more of the drivers uncomfortable sometime or most of the time. Similarly, median crossovers and merging to an

Figure 4.8a. Preferred Type of Work Zones


Figure 4.8b. Work Zone Preference by Truck Type


Note: Box (Box Van), Dbottom (Double Bottom), Tank (Tanker/Hopper, Chemical)
Flat (Flatbed/Platform, Lowboy), Special (Dump, Pole, Grain, Livestock, Auto-Transport)
open lane made at least half of the drivers feel uncomfortable sometimes or most of the times.
The ranking of the listed features, except driving in " S " curves, remained the same whether or not the frequency of responses to "Most of the times" was considered alone or combined with "Sometimes" category. A sensitivity analysis was conducted to assess the effects of combining the two response categories on the ranking of the uncomfortable feeling of the work zone features. When a driver indicated that a certain work zone feature made him uncomfortable "Most of the time", this response may be a stronger indicator than when a driver? said that the same feature made him uncomfortable "Sometimes." Thus, relative weights of $0 \%$ to $100 \%$ were assigned to the responses in the "Sometimes" category. The results are shown in Figure 4.9. For example, when the "Sometimes" responses are treated as important as the "Most of the times," responses (weight is $100 \%$ ), the ranking of the work zone features are those shown with a weight of $100 \%$. Similarly, if the responses to the "Sometimes" categories are not counted at all (weight is $0 \%$ ), the ranking is those shown with a weight of $0 \%$.

## Speed Limit

The opinions of truck drivers' about 55 mph speed limit in work zones were asked. About two thirds ( $62 \%$ ) answered that such a speed limit is about right, $25 \%$ said that the 55 mph speed limit is too fast while $8 \%$ responded that it is too slow (See Figure 4.10). It should be noted that the speed limit in Illinois interstate work zones is 55 mph , unless a $45-\mathrm{mph}$ speed limit is put into effect. When workers are present, regulatory $45-\mathrm{mph}$ speed limits are activated by turning on the two yellow strobe lights mounted on the speed limit signs.

Drivers were also asked to indicate how fast they would drive in work zones with a 45mph speed limit. The highest proportion (34\%) was found for those driving in the range 46-50 mph, followed by those driving at 45 mph ( $30 \%$ ) (see Figure 4.11). However, relatively high percentages were found at the ranges below $45 \mathrm{mph}(19 \%)$ and 51 mph and above ( $18 \%$ ). Thus, in a 45 mph speed zone, nearly half ( $48.4 \%$ ) of the drivers would drive at or below the speed limit, and the other half would exceed it. About $18 \%$ of drivers indicated that they would exceed the speed limit by more than 5 mph .

## Experience of Bad Driving Situations in Work Zone

Drivers were asked to mark on a work zone sketch the locations they had experienced bad driving situations. Two thirds of the surveyed drivers ( $66 \%$ ) said they had experienced bad driving situations (BDS) in one or more areas of the work zone: $37 \%$ in one location, $23 \%$ in two locations, $4 \%$ in three locations, $1 \%$ in four locations, and $1 \%$ in all five locations. The proportion of surveyed drivers with BDS was computed for different parts of the work zone.

Figure 4.9 Uncomfortable Feeling about Work Zone Features (Sensitivity Analysis)


Note: Weight shows the relative values of "sometimes uncomfortable." For example, if "sometimes.." is counted as much as "most of the times.." ( $100 \%$ ), the ranking is found on the most right-hand column. And if it is not counted at all ( $0 \%$ ), the ranking may be found on the most left-hand column.

Figure 4.10 Opinion on $55-\mathrm{mph}$ Speed Limit


Figure 4.11 Driving Speed in Work Zones w/ 45-mph Speed Limit


The transition area was the one with the highest proportion ( $45 \%$ ) followed by the advanced warning area ( $25 \%$ ), the work space ( $14 \%$ ), the termination area ( $11 \%$ ), and the buffer space $(10 \%)$. This indicated that about $59 \%$ of the drivers had experienced BDS in the advanced warning area and/or the transition area. This is a very high number and indicates that efforts for improving driving situations in the work zone for trucks should concentrate more in these two areas. The drivers complained that cars merge too late or try to pass the trucks right before the narrow section of the highway.

## Accidents in Work Zones

Similarly a sketch of work zones was given and the drivers were asked to mark the locations they had accidents in the work zones. A total of fifty one drivers said they had one or more accidents in the work zones. A more detailed analysis of the accidents are given in Chapter 9 of this report. A relatively small percentage of the surveyed truck drivers ( $6.1 \%$ ) said that they
had accidents in one or two locations in the work zones. About $1 \%$ had experienced accidents in two locations, and all of them included either the advanced warning area or the transition area. The percentages of drivers who had accidents in the advanced warning area, transition area, buffer space, the work space, or the termination area were $2 \%, 3 \%, 0.5 \%, 1 \%$, and $0.6 \%$, respectively. These numbers may seem small, but actually are not. For instance, approximately five out of every 100 drivers surveyed had accident(s) in the advanced warning area and/or transition area. This is more than twice the number of accidents in the remaining areas of the work zones. Accident experiences support the experience of bad driving situations.

Considering the number of accidents, $42 \%$ of them happened in the transition area, and

Figure 4.12 Frequency of Accidents (Among the Number of Accidents)


Notes: AWA(advanced warning area), TRA(transition area) BFS(buffer space), WKS (work space), TEA(termination area)
$29 \%$ happened in the advanced warning area (see Figure 4.12 ). Comments and suggestions of truck drivers revealed that most of the accidents happened between passenger vehicles and trucks mainly due to lane changes and rapid speed reductions. About $14 \%$ happened in the work space, $8 \%$ in the termination area, and only $7 \%$ in the buffer space.

Considering the number of drivers who had accidents and the number of accidents in the work zones, work zone improvement for truck drivers should focus on the transition area and the advanced warning area.

## Flaggers Visibility and Directions

About $63 \%$ of truck drivers said that the flaggers visibility is either okay or they are very visible. However, $32 \%$ said the flaggers are hard to see (see Figure 4.13). The reasons for this could be drivers inattention, inadequate contrast of flagger's attire, or position of flaggers in the work zones. The reasons for the inadequate visibility indicated by one third of the drivers should be determined and appropriate action should be taken to improve flagger's visibility.

Drivers were also asked about the clarity of the directions given by flaggers in work zones. Half of the truck drivers ( $49 \%$ ) said that it was confusing sometimes or most of the time while nearly the other half ( $46 \%$ ) said that it is usually clear (see Figure 4.14). Such a high proportion for the flaggers directions to be confusing surprised us because the respondents are professional truck drivers and see a lot of flaggers in work zones. The clarity of the directions given by the flaggers needs to be improved. It is interesting to note that in a different survey $(18,19)$ about $88 \%$ of the respondent (mostly car divers) correctly identified the flaggers message from the list of responses. This does not mean that truck drivers do not understand flaggers message, but it means that the directions given is not always clear and needs some improvements.

## Traffic Control Devices in Work Zones

Drivers were asked to indicate what they think about the following control devices in the work zones: cones, barricades, white plastic barricades, concrete barriers, barrels, tubes, and impact attenuators. A picture of each device was printed on the questionnaire to increase their recognition of the device and to avoid any confusion. They were asked to rate them as: "very helpful," "sometimes helpful," and "do not like their uses," and the results are listed in Table 4.3.

Among the traffic control devices, impact attenuators were ranked the highest in terms of helpfulness. About $61 \%$ of the truck drivers said the impact attenuators are very helpful and $24 \%$ mentioned that they are somewhat helpful. Only $8 \%$ of the drivers did not like their use. For concrete barriers, $54 \%$ said they are very helpful, followed by $16 \%$ that thought they are somewhat helpful. However, $28 \%$ said they do not like concrete barriers. Cones, white plastic barricades, and barrels were considered very helpful by more than $44 \%$ of the drivers, and

Figure 4.13 Visibility of Flaggers in Work Zone


Figure 4.14 Directions Given by Flaggers in Work Zone

somewhat helpful by $35 \%$ to $40 \%$ of them. For barricades, $42 \%$ said they are very helpful, $34 \%$ said somewhat helpful, and $22 \%$ do not like their use. Finally, for tubes, $36 \%$ of the drivers said they are very helpful, $39 \%$ mentioned that they are somewhat helpful, but $17 \%$ said they do not like their use.

When the category of "somewhat helpful" and "very helpful" were combined into the socalled "helpful" category, impact attenuators were still ranked the highest, followed by cones and white barricades. The third highest ranked group was barrels, tubes, and barricades. Concrete barriers ranked the lowest in "helpful" category, but they were not the lowest in "very helpful" category. Concrete barriers were also considered the highest ranked in "do not like their use" category.

A similar sensitivity analysis, which was applied to the work zone features, was conducted for the ranking of the helpfulness of control devices. Figure 4.15 shows the effects of relative weight of "somewhat helpful" category on ranking of these devices. For example, if the "somewhat helpful" category has as much weight as the "very helpful," category the ranking is shown on the most right-hand side of the graph. And if it is not counted at all, the ranking may be found on the most left-hand side of the graph.

## Arrow Boards and Changeable Message Boards

In the previous study [18] some truck drivers complained about brightness and height of arrow boards. In this survey, they were specifically asked about brightness and height of arrow boards and changeable message boards (CMB). In general, truck drivers do not have any problem with the height of the arrow board and $76 \%$ think the height is okay. However, $15 \%$ said it is too high and $5 \%$ said it is too low.

However, drivers seem to indicate that the brightness of arrow boards bother their eyes. About $76 \%$ said the arrow boards are too bright (see Figure 4.16). This shows that truck drivers may have a problem with the brightness of arrow boards. Several drivers made comments about brightness of arrow boards. The brightness concerns needs to be examined to increase the effectiveness of arrow boards and/or reduce their disturbing effects. A similar pair of questions were asked about CMB. Contrary to arrow boards, both height and brightness of CMB seem to be well accepted by the truck drivers. About $86 \%$ and $72 \%$ said that the height and the brightness are okay, respectively. Only $18 \%$ said that CMB are too bright.

## Confusing and Unclear Signs

Drivers were asked to indicate if they think there are any confusing or unclear signs in the work zones. Also, they were asked to indicate if there is a need to add any signs to work zones.

Figure 4.15 Helpfulness of Traffic Control Devices in Work Zone (Sensitivity Analysis)


| $\quad$ TCDs |
| :--- |
| - Cones |
| - Barricades |
| * Wht. Plastc Barricade |
| - Concrete Barriers |
| * Barrels |
| - Tubes |
| * Impact Attenuators |

Note: Weight shows the relative values of "somewhat helpful." For example, if "somewhat helpful" is counted as much as "very helpful" ( $100 \%$ ), the ranking is found on the most right-hand column. And if it not counted at all $(0 \%)$, the ranking may be found on the most left-hand column.

Figure 4.16 Brightness of Arrow Boards in Work Zone


Most of the truck drivers ( $86 \%$ ) said that they do not have any confusing or unclear signs to indicate. However, $14 \%$ said there were confusing and/or unclear signs. About $6 \%, 3 \%$, and $2 \%$ said there were confusing, unclear, and both confusing and unclear signs, respectively, in the work zones. The remaining $3 \%$ said there are confusing or unclear signs, but did not specify whether the signs were confusing or unclear.

Comments about confusing and unclear signs were directed toward lane closure, CMB, speed limit, exit ramps, and work zones without actual work. Drivers commented that it is unclear or confusing when a sign states that one lane is closed, but actually the other lane is closed. When a sign states that a lane is closed ahead, drivers want to know which one. Changing the location of the "Trucks Only" lanes too often also troubled drivers. Some drivers complained that CMB didn't always work or the messages flashed too fast.

Some drivers stated that speed limit signs in work zones are unclear and confusing. Alternate $45-\mathrm{mph}$ and $55-\mathrm{mph}$ speeds in work zones also caused problems for drivers. Some drivers find that exits in construction zones are not marked clearly. Drivers found signs posted when there is no work being done confusing and unclear. They complain that signs remain after construction is completed, conditions have changed, or construction has not yet begun. There were also complaints about $45-\mathrm{mph}$ speed zones when there are no workers present.

## Additional Signs, Comments, and Suggestions

About $78 \%$ said that there is no need to add signs or messages to Illinois work zones. However, $22 \%$ said some signs should be added. Almost all of the drivers ( $94 \%$ ) had driven through an Illinois work zone on the day of the survey, so they could easily remember what they had seen. Drivers suggested adding signs about early merging, early notification of work zones, road conditions, construction length, and speed limits. Drivers suggested adding signs to force cars to merge immediately to prevent the last minute merging. There were also suggestions for putting more merge signs, merge signs accompanied by law enforcement officers, and signs to make drivers aware of trucks trying to merge.

Drivers want to see more signs before the work zones and they want to see these signs sooner. A few drivers suggested that work zone notification begin 3-5 miles before the work zones. Several drivers feel merge signs are placed too close to the work zones and there is not enough time to merge. Drivers would also like to see that lane-closed-ahead sign specifies which lane is closed. Some drivers want to see signs displaying the distance to the lane closure. There were also suggestions for no passing zones when a lane is closed ahead.

Some drivers suggested adding signs for the road conditions of the temporary lane in the work zones such as width, uneven pavement, and shoulder drop-offs. There were also suggestions for notification of what type of work is being performed. Seven drivers want signs
stating the length of zone before the zone, and signs within the zone stating the distance left to travel. Drivers recommended signs instructing drivers to slow down in the work zones, and some proposed more speed limit signs. The drivers' suggestions and comments are analyzed in more detail in another chapter.

Table 4.1 Frequencies of Responses to Questions on Travel Characteristics

| Items | Proportions |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Type of Carrier | Common (62\%) | Contract (18\%) | Private (12\%) | Others (8\%) |
| Driving Hours | All Hours (88\%) | Daytime (10\%) | Nightrime (2\%) | - |
| Permit | $\begin{gathered} \text { No } \\ \text { (79\%) } \end{gathered}$ | Hazardous (15\%) | Over-dimension (5\%) | Combination ( $1 \%$ ) |
| Advance Sign | $3-5$ miles (47\%) | 1-2 miles ( $34 \%$ ) | 6-10 miles (14\%) | Others (5\%) |
| Hazard Assessment | More Hazard ( $90 \%$ ) | Less Hazard (1\%) | $\begin{aligned} & \text { Same } \\ & (8 \%) \end{aligned}$ | Don't Know (1\%) |
| Preferred Work Zone | Med. Crossover (36\%) | 1-Lane Closure $(33 \%)$ | No Preference (29\%) | No Opinion (2\%) |
| Speed Limit of 55 mph | About Right $(62 \%)$ | Too Fast (25\%) | Too Slow (9\%) | No Opinion (4\%) |
| Drive at 45 mph Speed Limit | $\begin{gathered} 46-50 \mathrm{mph} \\ (34 \%) \\ \hline \end{gathered}$ | At 45 mph (30\%) | $<45 \mathrm{mph}$ (19\%) | $\begin{gathered} >50 \mathrm{mph} \\ (17 \%) \\ \hline \end{gathered}$ |
| Visibility of Flaggers | $\begin{gathered} \text { OK } \\ (44 \%) \end{gathered}$ | Hard to See (32\%) | Very Visible (19\%) | No Opinion (5\%) |
| Directions by Flaggers | $\begin{aligned} & \text { Clear } \\ & (46 \%) \end{aligned}$ | $\begin{gathered} \text { Sometime } \\ \text { Confusing ( } 37 \% \text { ) } \\ \hline \end{gathered}$ | Most Times Confusing (12\%) | No Opinion (5\%) |
| Height of Arrow Boards | $\begin{gathered} \mathrm{OK} \\ (76 \%) \end{gathered}$ | Too High (15\%) | Too Low (5\%) | No Opinion (4\%) |
| Brightness of Atrow <br> Boards | Too Bright (76\%) | $\begin{gathered} \mathrm{OK} \\ (22 \%) \end{gathered}$ | Not Bright Enough (1\%) | No Opinion (1\%) |
| Height of Changeable Message Boards | $\begin{gathered} \text { OK } \\ (86 \%) \end{gathered}$ | Too Low (5\%) | Too High (4\%) | No Opinion (5\%) |
| Brightness of CMB | $\begin{gathered} \text { OK } \\ (72 \%) \end{gathered}$ | $\begin{gathered} \text { Too Bright } \\ (18 \%) \end{gathered}$ | Not Bright Enough (7\%) | $\begin{gathered} \text { No opinion } \\ (3 \%) \end{gathered}$ |
| Unclear/Confusing Signs | Yes (14\%) | No (86\%) | - | - |
| Add Signs | Yes (22\%) | No (78\%) | - | - |
| Drove through Work <br> Zone(s) Today | Yes (94\%) | No (6\%) | Don't Remember $(0 \%)$ | - |
| Suggestions | Yes (59\%) | No (41\%) | - | - |
| Comments | Yes (30\%) | No (70\%) | - | - |

Table 4.2 Frequencies of Responses to Questions on Work Zone Features

| Work Zone Features | Does Not Uncomfort ${ }^{1}$ | Sometimes Uncomfort ${ }^{2}$ | Most Times Uncomfort ${ }^{3}$ | Uncomfort ${ }^{4}$ | $\begin{gathered} \text { No } \\ \text { Opinion } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Merging to Open Lane | 47.1\% | 31.7\% | 17.9\% | 49.6\% | 3.3\% |
| Median Crossovers | 38.8\% | 37.3\% | 21.6\% | 58.9\% | 2.3\% |
| Lack of Shoulders | 12.7\% | 32.7\% | 53.4\% | 86.1\% | 1.2\% |
| Pavement Edge Dropoff | 10.7\% | 25.8\% | 62.3\% | 88.1\% | 1.2\% |
| Loose Const. <br> Materials | 12.2\% | 29.5\% | 57.3\% | 86.8\% | 1.0\% |
| Blowing Dirt/Dust | 18.3\% | 46.0\% | 33.9\% | 79.9\% | 1.8\% |
| Lane Width | 13.9\% | 39.6\% | 45.0\% | 84.6\% | 1.5\% |
| Driving in "S" Curves | 30.4\% | 47.1\% | 20.0\% | 67.1\% | 2.5\% |
| Lane Closure Taper Length | 38.8\% | 37.3\% | 21.6\% | 58.9\% | 2.3\% |

Notes:
(1) Does not make me feel uncomfortable.
(2) Makes me feel uncomfortable sometimes.
(3) Makes me feel uncomfortable most of the time.
(4) Sum of (2) and (3).
(5) No opinion.

Table 4.3 Frequencies of Responses to Questions on Traffic Control Devices

| TCD | Very <br> Helpful $^{1}$ | Somewhat <br> Helpful $^{2}$ | Helpful $^{3}$ | Don't Like <br> Their Use | No <br> Opinion $^{5}$ |
| :--- | :---: | :---: | :---: | :---: | :---: |
| Cones | $44.4 \%$ | $40.3 \%$ | $84.7 \%$ | $12.7 \%$ | $2.6 \%$ |
| Barricades | $41.5 \%$ | $34.3 \%$ | $75.8 \%$ | $21.9 \%$ | $2.3 \%$ |
| White Plastic <br> Barricades | $44.3 \%$ | $38.1 \%$ | $82.4 \%$ | $12.6 \%$ | $5.0 \%$ |
| Concrete <br> Barriers | $54.0 \%$ | $16.0 \%$ | $70.0 \%$ | $28.0 \%$ | $2.0 \%$ |
| Barrels | $44.3 \%$ | $34.9 \%$ | $79.2 \%$ | $18.7 \%$ | $2.1 \%$ |
| Tubes | $35.5 \%$ | $38.7 \%$ | $74.2 \%$ | $17.4 \%$ | $8.4 \%$ |
| Impact <br> Attenuators | $61.4 \%$ | $23.4 \%$ | $84.8 \%$ | $8.0 \%$ | $7.2 \%$ |

Notes:
(1) Are very helpful in work zones.
(2) Are somewhat helpful in work zones.
(3) Sum of (1) and (2).
(4) Do not like their use in the work zones.
(5) No opinion.

## CHAPTER 5

## TRUCK DRIVERS IDEAS FOR IMPROVING WORK ZONES

There were open-ended questions (questions $18,19,21$, and 22 ) that drivers could elaborate on their responses. The responses for these questions will be discussed in this chapter. The verbatim for these questions are given in Appendix C.

### 5.1. Unclear and Confusing Signs in Work Zones

### 5.1.1. Overall

Forty drivers wrote descriptions for confusing signs. However, there was not any consensus on what signs were confusing. Some wrote vague descriptions such as "messages more," "to slow," "directional," and "message boards." Some wrote comments or suggestions and some others described the message or sign that they considered confusing.

Sixty five drivers indicated that some signs are unclear. Several drivers referred to the area the signs are located, such as "Chicago area," or "Tri-State," rather than describing the unclear signs. Some comments were unclear such as "lane closing," "all," or "at nite." Some drivers made comments such as "merge immediately, not last minute," "not enough notice," and "need to notify driver of work zone ends."

The descriptions for confusing and unclear signs were combined because drivers' writeups indicated that they did not make a clear distinction between the two questions. A total of 99 drivers wrote descriptions for confusing/clear signs. The write-ups were reviewed and grouped into 6 topics: incorrect lane closure, other lane closure/change complaints, changeable message boards, speed limit, exit ramps, and no signs for no work. Table 5.1 shows the numbers of responses for each topic. Then, for each topic, the content of the responses were analyzed and a summary is provided as follows.

### 5.1.2 Incorrect Lane Closure

All ten drivers stated that it is unclear or confusing when a sign states that one lane is closed and when arriving at the work zone the other lane is actually closed.

### 5.1.3. Other Lane Closure/Change Complaints

Lane closures in general are the most unclear and confusing aspects of the work zone to
these drivers. When a sign states that a lane is closed ahead, drivers want to know which lane is closed, to have a sign saying merge now, and to have enough time to merge. Truck only lanes changing too often also troubled drivers.

### 5.1.4. Changeable Message Boards

Some drivers complained that the changeable message boards were confusing while others complaints were that they didn't always work, the messages flashed too fast, or changes too slow to read all the message.

### 5.1.5. Speed Limit

Many of the drivers state that sometimes the speed limit signs in work zones are unclear and confusing. A few said that alternate 45 mph and 55 mph speeds in work zones were unclear or confusing. Also a few did not know when to slow down.

### 5.1.6. Exit Ramps

Most drivers find that exits in construction zones are not marked clearly. Exit signs in general were found to be confusing.

### 5.1.7. No Signs for No Work

Drivers found signs posted when there is no work being done confusing and unclear. They complain that signs remain after construction is completed, conditions have changed, and construction has not yet begun. There were also complaints about 45 mph speed zones when there are no workers present.

Table 5.1 Unclear and Confusing Signs in Work Zones

| Topic | Number of Responses |
| :--- | :---: |
| Incorrect Lane Closure | 10 |
| Other Lane Closuré/Change Complaints | 15 |
| Changeable Message Boards | 5 |
| Speed Limit | 12 |
| Exit Ramps | 8 |
| No Signs If No Work Is Being Done | 8 |
| Other | 41 |
| Total | 99 |

### 5.2. Suggestions for Adding Signs or Messages to Work Zones

### 5.2.1. Overall

One hundred and fifty four drivers provided descriptions of what signs should be added to the work zones in addition to the signs usually placed. Compared to question 18, there was more consensus and clarity among the drivers' answers to this question. Comments such as "lane closure ahead, merge now or be ticketed," "move to an open lane before construction," " 1 mile before zone - SLOW DOWN - MERGE NOW," and " $3-5$ mile work zone ahead" clearly showed their needs for additional signs.

Moreover, several drivers mentioned not only new signs, but also how signs should be improved to better describe the work zone conditions. Such comments can be exemplified by statements like "need to extend warning of which lane is closed," "in cities, a lot earlier warnings of mergings," "cars slow down too," and "use changeable message boards in all work areas and not arrows." Other comments such as "too many drivers don't read signs," "more information is helpful," "keep workers in their work zones," "4 wheelers allow more space to truck driver," and "cars like to pass trucks," have not brought about a clear identification of signs that should be added.

These comments, however, show that the drivers were concerned about certain features or driving conditions in work zones. All suggestions were reviewed and topics were identified. Table 5.2 shows the topics and number of frequency of responses. When the comment made by the drivers could not be grouped into certain categories, the comment was included in the "other" category. The categories included merge now, advance notice of work zones, advance notice of lane closure, road conditions ahead, length of work zones, speed, and more message boards. The content of each comment was then analyzed, grouped into the above mentioned categories, and summarized within each category as follows.

### 5.2.2. Merge Now

The majority of the comments suggested adding signs to encourage the cars to merge before construction. Several drivers suggested putting sign to merge immediately (e.g., merge now). Several responses cite the last minute merging of vehicles as the cause of bottlenecks and delays. There were also suggestions for more merge signs, merge signs accompanied by law enforcement officers, and signs to make drivers aware of trucks trying to merge.

### 5.2.3. Advance Notice of Work Zone

Drivers wanted to see more warning signs before the work zone and they wanted to see these signs sooner. A few drivers suggested work zone notification begin 3-5 miles before the work zone, so they could have a chance to detour or be aware of delays.

### 5.2.4. Advance Notice of Lane Closure

Several drivers feel merge signs are placed too close to the work zone and there is not enough time to merge. A few drivers suggest signs placed 3-5 miles before the merge. Drivers would also like to see that Lane Closed Ahead sign specifies which lane is closed. Some drivers want to see signs displaying the distance to the lane closure. There were also suggestions for no passing zones when a lane is closed ahead.

### 5.2.5. Road Conditions Ahead

Almost all of the 12 comments in this category suggested adding signs for the road conditions of the temporary lane in the work zone such as width, uneven pavement, shoulder dropoffs, and grooved roads. There were also suggestions for notification of what type of work is being performed, and if workers are present or not in the work zones. Some drivers also pointed out specific signs indicated potholes and bumps in the work zones should be placed.

### 5.2.6. Length of Work Zone

There were only 2 different suggestions regarding length of work zone. Seven drivers want signs stating the length of zone before the zone and three drivers suggested signs within the zone stating the distance left to travel.

### 5.2.7. Speed

Half of the comments in this category recommend signs instructing drivers where and when to slow down in a work zone. Others proposed putting signs to indicate what speed is allowed and asking all vehicles to slow down.

### 5.2.8. More Message Boards

These driver responses suggest the use of message boards with clear and quicker messages. Drivers also suggested placing message boards in more work zones.

Table 5.2 Suggestions for Adding Signs or Messages to Work Zones

| Topic | No. of Responses |
| :--- | :---: |
| Merge Now | 30 |
| Advance Notice of Work Zone | 20 |
| Advance Notice of Lane Closure | 19 |
| Road Conditions Ahead | 12 |
| Length of Work Zone | 10 |
| Speed | 8 |
| More Message Boards | 6 |
| Other | 49 |
| Total | 154 |

### 5.3. Suggestions and Comments

### 5.3.1. Overall

Drivers were asked to make suggestions on how work zones in Illinois could be improved (question 21). Also, they were asked to make any additional comments (question 22). After analyzing all comments and suggestions from questions 21 and 22, it was concluded that drivers had used the two questions for a similar purpose. In other words, suggestions were made in question 22 when they were supposed to be made in question 21 . Similarly, comments were made in question 21 when they were supposed to be made in question 22 . Therefore, it was decided to combine the comments and suggestions into one category.

A total of 760 drivers made comments or suggestions covering a variety of issues. They were grouped into 25 different topics, plus the "other" category. Comments and suggestions were grouped into the "other" category when they did not belong to the 25 topics. Table 5.3 provide list of topics and number of responses.

The most commented category was related to lane width ( 79 drivers), followed by late merge complaints, get the job done right, shorter work zones, and arrow board brightness. Over 90 drivers made comments and suggestions on speed related categories. Truck drivers also complained about passenger car drivers and not patrolling the merge area. They also made comments or suggestions about flaggers, workers in travel lanes, traffic control devices in travel lanes, advanced warning of work zones and lane closures, surface conditions and pavement edge dropoff.

Finally, very specific categories addressed the problems of lighting in work zones, unclear merge complaints, less and shorter work zones, and CB radios and radar detectors. The comments and suggestions for each category are summarized below.

### 5.3.2. Lane Width

Despite the fact that the traveled lanes in highway work zones are to be kept 12-foot wide, the majority of the responses request widening of the open lanes through construction zones. Several drivers complain that the width of lanes is designed for cars and trucks cannot drive comfortably through the zones. A few drivers state that traffic control devices, concrete barriers and cones, infringe on the driving lane. Some drivers ask for wider lanes through construction zones and especially on bridges.

### 5.3.3. Late Merge Complaints

Of the sixty-four responses, forty-four were drivers complaints of cars speeding and passing to get to the front of the merge line or cars not merging at the proper time. There was the general suggestion to find a way to get all traffic to merge before the work zone. Some suggested that officers ticket drivers that do not merge at the proper time. A few drivers commented that traffic does not obey merge signs.

### 5.3.4. Unclear Merge Complaints

Almost half of the eleven drivers want to see the merge problem solved somehow. A few of them suggested using longer taper lengths so as to make the merge more gradual. Also, it was suggested to merge traffic in advance of the construction zones.

### 5.3.5. Arrow Board Brightness

The general consensus of these responses is that arrow boards are too bright and blinding, especially at night. There were several suggestions to relieve this problem. Most drivers want the lights to be dimmed. A few suggested that the arrow board be turned at an angle away from the drivers eyes. Some drivers suggested changing the height of the board so it is not at eye level.

### 5.3.6. Lighting Complaints

There was not a clear consensus about lighting. A few of these drivers suggested using message boards more with green or blue writing because they are clear and easy to read. There were a couple comments on the use of reflectors, long lines of yellow lights, and not flashing arrow boards.

### 5.3.7. Flaggers

Most drivers suggested that flaggers, for their own safety, need to stand in the clear, further off the roadway. There were several suggestions that flaggers need to stand further from the work zone because they are not seen until you are already in the zone. A few drivers suggested the use of more educated flaggers. Flaggers need to make themselves more visible.

### 5.3.8. Workers in the Travel Lane

Almost all the drivers responses state that workers need to stay in the work zone and not in the travel lane. They state that workers are not aware of the traffic around them and they are not careful enough. Workers seem to try to challenge drivers by remaining in the driving lane.

### 5.3.9. Traffic Control Devices in the Travel Lane

These drivers all suggested that something be done about traffic control devices that encroach upon the travel lane. Most drivers seemed to have problems with cones and barrels which blow or drift into the lane. Others complained about barricades or concrete barriers. Suggestions were made to weight down barrels and cones, so they can not be pushed toward the traveled lanes.

### 5.3.10. Speed Complaints

There was no real consensus among all of these drivers ideas. Nearly half of them suggest to slow traffic down in the work zone. A few complained about passenger cars driving too fast. There were general comments stating "speed limit" and there were specific suggestions of speed limits of 45 and 55 mph through the work zone. Some drivers want to see traffic flowing at a constant speed through the work zone. A few drivers complained that some traffic does not even maintain the posted speed limit. Only 2 drivers wanted speed limit to be increased.

### 5.3.11. Shorter Work Zones

Most drivers complained that the work zone was too long and it needs to be shorter. Many drivers complained that there is too much roadway closed for the size of the job being performed. For example, three miles of roadway is closed for a half mile project. A few drivers suggested finishing one section before going to work on another section. Many drivers were unhappy to drive through a work zone to see that no work was being done. They indicated that if no work is being done, the lane should be open.

### 5.3.12. Less Work Zones

Many of the drivers simply responded that there are too many work zones. Many had complaints that there are too many in certain areas, especially the Chicago Land Area. A few
drivers suggested not starting another project until the present job is completed. A few drivers would like to see less work zones on the same roadway at the same time.

### 5.3.13. Advanced Warning of Work Zones

The general consensus of these drivers is that they need more advanced warning signs and they would like to see these warnings placed further away from the work zones. Some drivers would like long range notice of work zone and delays so they could plan a route change. There were also requests for more notice in cities. In general, drivers complain not only about the placement of the advanced warning signs, but also about the quality of the information given to them.

### 5.3.14. Advanced Warning of Lane Closure

As with the work zones, drivers would like to see more advanced warning of lane closure signs. Some drivers wanted to see these warning signs placed well in advance of work zones. A few drivers requested lane closure signs to specify which lane is closed.

### 5.3.15. Get the Job Done Right/Faster

Most of the drivers state that repair takes too long and the work need to be completed faster. Some suggested working 24 hours a day and 7 days a week to complete the job quickly. Many of the drivers simply say " Get it Done ". There were some suggestions that if the roads are done right the first time, there will be no need for constant repair efforts. A few drivers suggested the use of better quality labor and materials.

### 5.3.16. Surface Condition

The majority of drivers want to have a smooth and even lane to drive through without any bumps or potholes. There were a few suggestions for smoother transitions on and off bridges in work zones. A few drivers suggested that if they had to drive on the shoulder, that the shoulder be in good condition. Bumps and potholes considerably disturb truckers, and signs should be placed to warn them of their presence.

### 5.3.17. Edge Dropoff

The drivers request that there be no edge dropoff from the travel lane because it is hard
to control the truck or trailer.

### 5.3.18. Patrol for Speed

The majority of drivers want stricter and better enforcement of the speed limit through the work zone. A few drivers suggested stricter laws for speeding through a work zone. Many drivers suggested more police present in the work zone to control speeding.

### 5.3.19. Patrol for Merge Area

Many of the responses to this question suggest that police should be present at the entrance to work zones to ticket people who pass and speed to get to the work zone. A few stated that police presence would deter last minute merging. A few drivers stated that generally there should be more patrol in the work zone area.

### 5.3.20. Perform Work in Off-Peak Hours

All of these drivers stated that work should be done in off-peak hours. There were a few suggestions for construction in the late night or early morning hours. A few drivers stated work should be done any time except rush hour.

### 5.3.21. Satisfactory Work Zone Conditions

Driver responses were either that Illinois was doing okay in the work zones or that there was really nothing more that Illinois could do to improve the zones at this time.

### 5.3.22. Car Complaints

Many of the complaints were that car drivers do not comply with work zone rules, especially speed and merging. Several of the drivers suggest a more stringent driver education program for car drivers. A few drivers suggest education on car-truck relations. There were also a few comments stating that car drivers don't read signs. Some drivers complained cars travel too slow while others complained they travel too fast.

### 5.3.23. Higher Truck Speeds

The general consensus of these drivers is that Illinois' speed limit of 55 mph for trucks
needs to be higher. Some suggest 65 mph while others suggest at least 60 mph .

### 5.3.24. Equal Speeds for Cars and Trucks

All of these drivers believe the speed limit should be the same for cars and trucks. Most of the drivers cite safety reasons for this equal speed. Most of the drivers don't care whether the speed limit is 55 or 65 mph , as long as it is the same.

### 5.3.25. CB Radios/Radar Detectors

The drivers commenting on CB's felt that the law prohibiting them was unfair because the radios are very helpful to the drivers. All of the drivers commenting on radar detectors want the right to use them in their vehicles. Several cited that it is discrimination to allow cars to have them but not trucks.

### 5.3.26. Illinois Roads Are in Poor Shape

Several drivers suggested that Illinois continue working on the roads because they are in bad shape. A few stated that Illinois should not let the roads get as bad as they do before working on them.

Table 5.3. Suggestions and Comments about Illinois Work Zones

| Topic | Number of Responses |
| :--- | :---: |
| Lane Width | 79 |
| Late Merge Complaints | 64 |
| Unclear Merge Complaints | 11 |
| Arrow Board Brightness | 36 |
| Lighting Complaints | 10 |
| Flaggers | 13 |
| Workers in Travel Lane | 32 |
| Traffic Control Devices in Travel Lane | 8 |
| Speed Complaints | 28 |
| Shorter Work Zones | 43 |
| Less Work Zones | 16 |
| Advanced Warning of Work Zones | 27 |
| Advanced Warning of Lane Closure | 13 |
| Get the Job Done Right/Faster | 58 |
| Surface Conditions | 24 |
| Edge Dropoff | 12 |
| Patrol for Speed | 24 |
| Patrol of Merge Area | 28 |
| Perform Work in Off-Peak Hours | 16 |
| Satisfactory Work Zone Conditions | 29 |
| Car Complaints | 27 |
| Higher Truck Speeds | 32 |
| Equal Speeds for Cars and Trucks | 9 |
| Legal CB Radios and Radar Detectors | 17 |
| Illinois Road Are in Poor Shape | 12 |
| Total | 760 |
|  |  |

## CHAPTER 6

## CORRELATION ANALYSIS OF TRAVEL CHARACTERISTICS

## Statistical Methods

Correlation analyses were conducted to identify the relationships among the responses to different questions. Different statistical tests were used, based on the distribution characteristics of the responses for each question, as well as on the number of groups to be compared (see Table 3.3 in Chapter 3). There are two different types of variables: continuous and discrete. A continuous variable (such as drivers age) has an exact numerical value assigned to it, however, a discrete variable (such as truck type) represents a category.

For the relationships among continuous variables (e.g. age vs miles driven) Pearson's correlation coefficients $r$ were checked (see the results in Table 6.1). For the relationships between continuous and discrete variables (e.g. age vs truck type) the F-tests (one-way analysis of variance (ANOVA)) were applied (see the results in Table 6.2 at the end of this chapter). For the relationships between discrete and discrete variables (e.g. truck type vs permit type) comparisons were made using $\chi^{2}$ goodness-of-fit tests (see the results in Table 6.3 at the end of this chapter). The F-tests and $\chi^{2}$ goodness-of-fit tests were performed with a $90 \%$ confidence level. This chapter discuss only the relationships that are significant with a $90 \%$ confidence level. It should be noted that the higher the values in Table 6.1, the stronger the correlations. It should also be noted that Tables 6.2 and 6.3 indicate whether the correlations were significant with a $10 \%$ significance level. The actual values for the significance levels are given in Appendix D.

The GLM (general linear model) procedure in SAS was used for the ANOVA because of unbalanced situations [17]. An unbalanced situation is when there are unequal number of observations for different combinations of class variables, which is the case in this survey. SAS recommends, in this situation, to use the GLM procedure instead of the ANOVA procedure. For continuous variables the GLM results will show whether or not the average values for all groups are the same or whether there are at least two groups with different mean values. We looked at $F$-values in the GLM output to make such judgements. If $F$-values showed that they were significantly different, we looked at the results of Duncan's Multiple Range Test to see which groups are different. In the case of two groups, $t$-test also can be used to find out the mean difference of two groups.

Table 6.1 Pearson's Correlation Coefficients of Continuous Variables

|  | Driving <br> Experience | Miles Driven <br> in U.S. | Miles Driven <br> in Illinois | Age of <br> Driver |
| :---: | :---: | :---: | :---: | :---: |
| Driving Experience | 1.0000 | 0.1867 | 0.1219 | 0.7426 |
| Miles Driven in U.S. | 0.1867 | 1.0000 | 0.2010 | 0.1072 |
| Miles Driven in Illinois | 0.1219 | 0.2010 | 1.0000 | 0.0592 |
| Age of Driver | 0.7426 | 0.1072 | 0.0592 | 1.0000 |

For the discrete variables, $\chi^{2}$ goodness-of-fit tests were used. Drivers were grouped into several (two or more) categories based on responses of question items. Each group was further divided into various travel characteristic sub-groups. The test was used to see if certain drivers were over- or under-represented. These tests would identify if an unexpected number of drivers have certain characteristics. In these tests, SAS recommends that no more than $20 \%$ of the cells should have expected values less than 5 if the degree of freedom is greater than one [17]. When the original classification of each item in the questionnaire was not suitable for these tests, each item was re-classified (see Table 3.4 in Chapter 3).

The correlations between the responses to one question versus all other questions were analyzed. This involved examining correlations among over 40 question items. It should be noted that the correlation between question 5 and 9 is the same as the correlation between question 9 and 5. The correlations are discussed in the following sections for each pair (the discussion is given for only one pair). Figure 6.1 (included at end of this chapter) shows how the discussion for the other pair can be found, if desired.

## Driving Experience vs Remaining Questions

Age (Q3): There is a strong positive relationship between driving experience and age of drivers ( $r=0.7426$ ). This shows that most drivers started their professional truck-driving career when they were young.

Type of Truck (Q4a): The years of truck driving experience was correlated to the type of trucks. For example, the double bottom truck drivers had more experience ( 23.8 years), while the box van drivers had less driving experience ( 14.4 years).

Advance WZ Sign (Q7): The general trend indicated that the less experienced drivers wanted to find out about WZ far in advance than more experienced drivers. Those who wanted the advance warning sign in less than 1 mile, 1-2, 3-5, and 6-10 miles had respectively $23.8,20.5$, 17.3 , and 16.2 years of experience. While the F-test showed a significant difference in driving experience, Duncan's test failed to distinguish significant differences among the groups.

Hazard of WZ (Q8): Assessment of hazard of traveling in WZ was correlated with truck driving experience. Drivers who said traveling in WZ is more hazardous than non-work zones were less experienced ( 15.8 years) than those who said the hazard is the same as in non-work zones (18.6 years).

Preferred WZ layout (Q9): Truck drivers who said that they do not have a preference between median crossovers and one-lane closures were more experienced ( 17.3 years) than those who preferred one-lane closures ( 15.0 years average). The difference in years of experience for those who prefer one-lane closures and median crossovers was not statistically significant.

WZ Features (Q10B, 10C, 10D, 10E, 10G, 10H): Six out of the nine WZ features were correlated with driving experiences when comfort levels were analyzed. Truck drivers who said that median crossovers, lack of shoulders, pavement edge dropoff, loose construction materials, lane width, or driving in " S " curves do not make them feel uncomfortable have more driving experience than those who said that they do feel uncomfortable with such work zone features.

Speed limit of 55 (Q11A): The truck driving experience of those who said that the 55 mph speed limit is too fast was higher ( 18.3 years) than of those who said it is too slow or about right ( 15.5 and 14.9 years, respectively). The average experience of those who indicated that the 55 mph speed limit is too slow was not statistically different from those who said it is about right.

Speed in 45 zone (Q11B): How fast a driver travels in work zones with a 45 mph speed limit was correlated to his years of truck driving experience. Drivers with more experience traveled slower than drivers with less experience. The average driving experience of those who indicated that they drive at 45 mph or less (ranging from 17.8 to 18.9 years) was higher than those who drive over 45 mph (ranging from 11.0 to 15.7 years). The average driving experience of those who indicated that they drive at $46-50 \mathrm{mph}$ ( 15.7 years) was also higher than those who drive over 50 mph (ranging from 11.0 to 11.1 years). Within the subgroups of driving speed at 45 and $46-50 \mathrm{mph}$ there was no difference.

Flagger Visibility (Q14A): How visible flaggers are in work zones was also correlated to truck
driving experience. Drivers who pointed out that flaggers are hard to see or said they are very visible had more driving experience ( 17.4 and 16.5 years, respectively) than those who said flagger's visibility is okay ( 14.6 years).

TCD (Q15D and Q15G): The usefulness of concrete barriers was correlated with driving experience. Drivers who said that concrete barriers are helpful were more experienced ( 17.0 years) than the ones who indicated that they do not like their use ( 15.9 years). The usefulness of impact attenuators was also correlated with driving experience. Drivers who said that impact attenuators are helpful were more experienced ( 16.5 years) than the ones who indicated that they do not like their use ( 14.1 years).

Brightness of Arrow Boards (Q16B): Brightness of arrow boards was correlated with the driving experience. Drivers who said arrow boards are too bright ( 16.5 years) had more driving experience than those who said they are bright enough ( 14.9 years).

Unclear and Confusing Signs(Q18): The indication of unclear or confusing signs in the Illinois work zones was correlated with the driving experience of truckers. Drivers who said that there are confusing or unclear signs in work zones had more driving experience ( 18.9 years) than those who said that there are not ( 15.7 years).

## Miles Driven vs Remaining Questions

Type of Truck (Q4a): Average miles driven by truck drivers were correlated with the truck type. Overall, box van trucks ( 117.4 K miles) drivers traveled more miles than tanker trucks ( 106.3 K miles), flatbed ( 102.3 K miles) or special purpose trucks ( 99.8 K miles average). Also the double bottom trucks traveled more miles ( 113.0 K miles) than the flatbed trucks and special purpose trucks.

Carrier Type (Q4b): The general trend is that truck drivers for common carriers drove a little more miles $(114.8 \mathrm{~K})$ than those for private $(108.5 \mathrm{~K})$ or contract carriers $(107.4 \mathrm{~K})$. While F tests showed a significant difference in miles driven, Duncan's test failed to isolate the difference.

Time of Driving (Q5): Miles driven by drivers who drove all hours ( 114.9 K miles) was found to be higher than those by drivers who drove just during daytime ( 90.4 K miles average).

Preferred WZ Layout (Q9): The preference of WZ layout was correlated with miles driven. Those who did not have any preference ( 118.2 K miles) drove more than the ones who preferred median crossovers ( 108.1 K miles) or one-lane closure ( 108.1 K miles). However, miles driven by the truckers who preferred one-lane closure was not different from those by drivers who preferred median crossovers.

WZ Features (Q10A, 10B, 10C, 10F, 10G): The comfort level of five out of the nine listed work zone features were correlated to the number of miles driven. Drivers who indicated that merging to open lane, median crossovers, lack of shoulders, blowing dirt or dust, or lane width do not make them feel uncomfortable drove more miles.

Speed Limit of 55 (Q11A): Truck drivers who said that $55-\mathrm{mph}$ speed limit in work zones is about right drove more ( 114.57 K miles) than those who said that the speed limit is too slow ( 104.34 K miles).

Speed Zone of $\mathbf{4 5}$ (Q11B): Truck drivers who indicated that they drive at speeds higher than 50 mph in 45 mph speed limit work zones drove more ( 136.8 K miles) than all the other groups. Among the subgroups of driving speeds below 50 mph , there was no significant difference in miles driven last year.

Flagger's Visibility (Q14A): The visibility of flaggers in work zones was also found correlated to the number of miles driven by truckers last year. Drivers who indicated that flaggers are hard to see drove more ( 117.5 K miles) than the ones who said that flaggers are very visible ( 110.1 K miles) or their visibility is okay ( 109.3 K miles). Statistically there was no significant difference in miles driven among those who said that flaggers are very visible or their visibility is okay.

Height of Arrow Board (Q16A): The height of arrow boards was found correlated to miles driven. Drivers who said that arrow boards are too low drove more ( 125.4 K miles) than those who indicated that the height is okay ( 110.4 K miles).

Additional Signs (Q19): The need for adding signs to Illinois work zones was correlated with the number of miles driven. Drivers who said that signs should be added to work zones drove more (average 118.6 K miles) than those who indicated no need for adding signs to the Illinois work zones ( 110.2 K miles).

## Miles Driven in Illinois vs Remaining Questions

Truck Type (Q4A): The number of miles driven in Illinois last year by double bottom truck drivers ( 36.1 K miles) was found not statistically different from that by tankers ( 30.5 K miles) or special purpose truck drivers ( 30.1 K miles). However, they were significantly different than the number of miles driven by drivers of box vans ( 23.9 K miles) and flatbeds ( 20.1 K miles).

Carrier Type (Q4B): The number of miles driven in Illinois last year by private carriers ( 31.2 K miles) was higher than that by common and contract carriers ( 25.1 K and 23.2 K miles, respectively).

Time of Driving (Q5): Daytime drivers drove more ( 34.1 K miles) than all-hour drivers (24.2K miles average) in Illinois.

WZ Features (Q10B): Drivers who mentioned that median crossover did not make them feel uncomfortable drove more miles in Illinois last year ( 26.7 K miles) than those who said that median crossover made them uncomfortable ( 23.7 K miles).

Speed Limit of 55 (Q11A): When asked about the 55 mph speed limit in work zones, the number of miles driven in Illinois showed statistically significant differences. Truckers who said that the 55 mph speed limit is too fast drove more in Illinois ( 28.6 K miles) than those who said that the speed limit is too slow ( 20.1 K miles).

Speed Zone of 45 (Q11B): How fast a truck driver travels in a 45 mph WZ was related to the miles driven in Illinois. The average miles driven by those who indicated that they drive below 45 mph ( 29.7 K miles) were higher than those who drive $56-60 \mathrm{mph}$ ( 21.3 K miles). There is no statistically significant difference among other subgroups.

WZ Accidents (Q13): Accidents were related to the number of miles driven in Illinois. Drivers who had accidents drove more in Illinois ( 33.0 K miles) than those who had no accidents ( 24.8 K miles).

TCD (Q15D): Truck drivers who think that concrete barriers are helpful drove more in Illinois ( 26.7 K miles) than those who said that they do not like the use of concrete barriers in work zones ( 21.8 K miles).

Brightness of Arrow Boards (Q16B): The brightness of arrow boards was also found correlated
to the number of miles driven in Illinois. Drivers who mentioned that the arrow boards brightness is okay drove more ( 33.8 K miles) than those who indicated that arrow boards are too bright ( 22.8 K miles).

## Driver Age vs Remaining Questions

Type of Truck (Q4A): Drivers' ages were correlated with the truck types they drove at the time of the survey. The average age of double bottom truck drivers was higher ( 48.6 years) than that of all other truck types. The lowest average age belonged to box vans drivers ( 41.6 years).

Advanced WZ sign (Q7): How far in advance drivers should be notified about work zones was correlated with the age of truck drivers. The age of those who would like to know about a work zone ahead 2 or less miles in advance was higher (between 45.6 and 47.1 years) than that of those who wanted it to be 3 or more miles ahead (between 40.8 and 41.4 years).

Preferred WZ Layout (Q9): The average age of those who have no preference between median crossover and one-lane closure was found significantly higher (44.1 years) than those who prefer one-lane closure (41.1 years).

WZ Features (Q10A, 10E, 10F, 10): The assessment of the discomfort level for merging to an open lane, loose construction materials on open lane, blowing dirt or dust, or lane closure taper length were correlated to the age of the drivers. The average age of the drivers who said that such items, except loose construction materials, make them feel uncomfortable was higher than of those who indicated that such items do not make them uncomfortable. However, drivers who said loose construction materials make them uncomfortable were younger than the others.

Speed (Q11A and Q11B): The driver who said that 55 mph speed limit is too fast were older ( 45.1 years average) than the ones who said it is too low or about right. Similarly, the average age of those who said that they drive at 50 mph or less in a WZ with a 45 mph speed limit was more (between 42.6 and 45.6 years) than the ones who drove over 50 mph (between 35.2 and 38.0 years). Those who drive at 45 mph were older than those who drive at $46-50 \mathrm{mph}$, and those who drive at $51-55 \mathrm{mph}$ were older than those who drive over 55 mph .

Flagger's Visibility (Q14A): How visible flaggers are in work zones was also correlated to the average age of truck drivers. Thus, those drivers who indicated that flaggers are hard to see were older (44.1 years) than those who said flagger's visibility is okay ( 43.1 years).

TCD (Q15D and Q15G): How useful concrete barriers and impact attenuators are to truck drivers was correlated to their age. Those who said that such devices are helpful were older (43.4 and 43.2 years, respectively) than the ones who do not like their use ( 41.4 and 40.1 years, respectively).

Brightness of Arrow Board (Q16B): The truck drivers who said that arrow boards are too bright were older ( 43.5 years average) than those who indicated that brightness is okay (41.3 years).

Unclear and Confusing Signs (Q18): The truckers who pointed out that there are unclear or confusing signs in the Illinois work zones were older ( 44.8 years) than those who said that such signs do not exist in Illinois ( 42.5 years average).

## Types of Truck Driven vs Remaining Questions

Carrier Type ( $\mathbf{Q 4 B}$ ): The type of truck operated by a company was correlated with the type of carrier represented by that company. For example, the special-purpose trucks (i.e., dump, pooled, grain, and livestock trucks) were over-represented in the contract carriers, and the double-bottom trucks were over-represented in the common carriers.

Time of Driving (Q5): The type of truck was correlated with the time of driving. For example, the special-purpose trucks were driven more at daytime than other truck types.

Permits (Q6): The type of truck was correlated with the type of permit carried by the truck driver. For example, a higher proportion of flatbed and lowboy truck drivers were carrying over-dimension permits than other truck types. Similarly, a higher proportion of tanker and chemical truck drivers were carrying hazardous materials permits.

WZ Features (Q10A, 10E, 10G, and 10H, 10I): The type of truck was correlated with the level of discomfort in merging to an open lane in work zones. Double bottom truck drivers felt that merging to an open lane make them more uncomfortable than other truck driver's.

The type of truck was correlated with the level of discomfort due to loose construction materials on open lanes. Box van drivers were under-represented in a group who said that loose construction materials on open lanes do not make them uncomfortable. However, special purpose truck drivers were over-represented in that group.

The type of truck was also correlated with the level of discomfort due to lane width in
work zones. A higher proportion of box van drivers felt that lane width makes them uncomfortable.

The type of truck was also correlated with the level of discomfort of driving in "S" curves and lane closure taper length. As an example, a higher proportion of box van and double bottom drivers felt that driving in " S " curves and lane closure taper length make them uncomfortable.

Speed Limit of $\mathbf{5 5}$ (Q11A): The type of truck was correlated with the way truck drivers think about the speed limit of 55 mph in work zones. While special purpose truck drivers were overrepresented in those who said the speed limit of 55 mph is too slow, double bottom truck drivers were over-represented in those who said the speed limit of 55 mph is too fast. And those driving box vans were over-represented in those who indicated that the speed limit of 55 mph is about right.

Speed Zone of 45 (Q11B): The type of truck was also correlated with how fast truck drivers travel in a work zone with 45 mph speed limit. Box van drivers were over-represented and double bottom drivers were under-represented in those who said that they usually travel above 50 mph in a 45 mph speed limit.

BDS (Q12): The type of truck was correlated with the experience of bad driving situations in work zones. As an example, A higher proportion of double bottom truck drivers have faced bad driving situations in work zones that other truck types. Chemical and tanker drivers were underrepresented in experiencing bad driving situations in work zones when compared to others.

Flagger's Visibility (Q14A): The type of truck was correlated with the visibility of flaggers in work zones. For example, flatbed truck drivers were under-represented in those who said that flaggers are very visible in work zones, and they were over-represented in those who answered that they have had a hard time seeing flaggers. Double bottom truck drivers were overrepresented in those who said that flaggers are very visible. However, special purpose truck drivers were under-represented in those who indicated that flaggers are hard to see.

TCD (Q15D): Drivers of all types of trucks, except box vans, were over-represented in those who said that concrete barriers are helpful. But box van drivers were over-represented in those who said that they do not like their use in work zones.

## Type of Carrier vs Remaining Questions

Advance WZ Sign (Q7): Drivers who belong to contract carriers were over-represented in those who wanted to find out about a work zone less than 1 mile ahead, and were underrepresented in those who preferred to find a work zone $3-5$ miles ahead. Drivers who belong to private carriers were under-represented in those who wanted to find out about a work zone 1-2 miles ahead, and were over-represented in those who liked to find work zones more than 5 miles ahead.

Hazard of Traveling in WZ (Q8): Drivers who drove trucks for common carriers were overrepresented in a group of drivers who said hazard of driving through work zones is almost same as that of driving through non-work zones. However drivers for private carriers were underrepresented in that group.

BSD (Q12): The type of carrier was correlated with the experience of bad driving situations in work zones. Common carrier drivers were over-represented in experiencing bad driving situation in work zones compared to the other carrier types. The diversity of drivers and truck types in the common carrier might be one of the causes of such correlations.

Flagger's Directions (Q14B): A correlation was found between carrier type and the directions given by flaggers in work zones. Drivers for private carriers were under-represented in those who said directions given by flaggers are usually clear, they were over-represented in those who said directions given by flaggers are confusing most of the time.

TCD (Q15D): The type of carrier was correlated with the level of appreciation of concrete barriers. For example, drivers of private carriers were over-represented in those who said that they like the use of concrete barriers in work zones.

Brightness of Arrow Board (Q16B): The type of carrier was correlated with the perception of brightness of arrow board. Drivers of private carrier were over-represented in those who answered that the brightness of arrow boards is okay.

Brightness of Changeable Message Board (Q17B): The type of carrier was also correlated with the perception of brightness of changeable message Boards (CMB). For example, drivers of contract carrier were over-represented in those who indicated that the brightness of CMSs is not enough.

## Time of Driving vs Remaining Questions

Permit (Q6): Time of the day when truck drivers usually drive was correlated with the type of permit they carry. For example, drivers who usually drive during daytime were over-represented in those who carry permits for over-dimension, but they were under-represented in those who carry permits for hazardous materials.

WZ Features (10A, 10B, 10E, 10G): Daytime drivers were over-represented in those who said that merging to an open lane, median crossovers, and loose construction materials on an open lane make them feel uncomfortable. Daytime drivers were over-represented in those who mentioned that lane width does not make them feel uncomfortable in work zones.

Speed limit of 55 (Q11A): The speed limit of 55 mph in work zones was found to be correlated with the time truck drivers usually drive. For example, daytime drivers were over-represented in those who said that such a speed limit is too slow, but they were under-represented in those who indicated that the 55 mph speed limit is about right.

TCD (Q15D): The usefulness of concrete barriers was correlated with the time truck drivers usually drive. Daytime drivers were under-represented in those who said that concrete barriers are helpful.

Height of Arrow Board (Q16A): The height of arrow boards in work zones was correlated with the time truck drivers usually drive. Daytime drivers were under-represented in those who said that arrow boards are too high.

Brightness of Arrow Board (Q16B): The perception of brightness of arrow boards was correlated with the time truck drivers usually drive. Daytime truck drivers were underrepresented in those who indicated that arrow boards are too bright. This implies that the brightmess is more of a problem for those who drive all hours.

Additional Signs (Q19): The need to add more signs or messages in Illinois work zones was correlated with the time truck drivers usually drive. Daytime truck drivers were underrepresented in those who indicated more signs or messages in Illinois work zones.

## Carrying Permit vs Remaining Questions

Height of Arrow Board (Q16A): Drivers carrying permits for hazardous material were overrepresented in those who said that arrow boards are too high, but they were under-represented in those who said the height is okay.

Additional Signs (Q19): Drivers carrying hazardous material permits were over-represented in those who said that signs should be added. However,drivers who carry over-dimension type of permit were under-represented in those who indicated that signs should be added in the Illinois work zones.

## Advance WZ Sign vs Remaining Questions

WZ Features (Q10G): Drivers who wanted to find out about a work zone 1-2 miles in advance were over-represented in those who do not feel uncomfortable with the width of the travel lanes in work zones. But drivers who wanted to find out about a work zone $3-5$ miles in advance were under-represented in those who do not feel uncomfortable with the width of the travel lanes in work zones.

Flagger's Visibility (Q14A): Drivers who wanted to find out about a work zone less than 1 mile ahead were over-represented in those who said flaggers are very visible. However drivers who wanted to find out about a work zone more than 5 miles ahead were over-represented in those who said flaggers are hard to see.

Brightness of Arrow Board (Q16B): Drivers who wanted to find out about a work zone less than 1 mile ahead were over-represented in a group of drivers who said arrow boards are too bright. However drivers who wanted to find out about a work zone more than 5 miles ahead were under-represented in that group.

## Hazard in Work Zones vs Remaining Questions

Preferred WZ Layout (Q9): The perception of hazard of driving through WZ compared to nonwork zones was correlated to the preferred work zone layout (median crossover or one-lane closure). For example, drivers who said work zones are more hazardous than non-work zones were over-represented in those who prefer one-lane closure, but they were under-represented in
those who have no preference between the two kinds of work zone layouts.
WZ Features (Q10): Seven out of the listed nine work zone features were correlated to the assessment of travel hazard in work zones. Drivers who think work zones are more hazardous were over-represented in those who indicated that merging to an open lane, median crossovers, lack of shoulders, pavement edge dropoff, lane width, driving in "S" curves, and lane closure taper length make them feel uncomfortable. However, drivers who perceive hazard in work zones the same as in non-work zones were over-represented in those who said that the seven work zone features do not make them uncomfortable.

BDS (Q12): The perception of hazard in work zones was also correlated with experiencing bad driving situations in work zones. Drivers who replied that the hazard in work zones is the same as non-work zones were under-represented in those who said that they have experienced bad driving situations in work zones. However, drivers who perceived work zones to be more hazardous were over-represented in those who indicated that they have experienced bad driving situations in work zones.

Additional Signs (Q19): Drivers who answered that work zones are the same as non-work zones in the terms of hazardousness were under-represented in those who said that signs should be added.

## Preferred WZ Layout vs Remaining Questions

WZ Features (Q10): The preference of work zone layout was correlated with all of the listed work zone features. Drivers who prefer median crossover or one-lane closure were overrepresented among those who said that the listed work zone features, except median crossovers and driving in "S" curves, make them feel uncomfortable. Among the drivers who said that median crossover or driving in "S" curve make them feel uncomfortable, the drivers who prefer median crossover were under-represented, however the drivers who prefer one-lane closure were over-represented. Among those who mentioned no preference, a higher than expected proportion answered that any of the listed work zone features do not make them feel uncomfortable.

TCD (Q15B, 15E, and 15F): The preference of work zone layout was correlated with the presence or use of barricades, barrels, and tubes in the work zones. Drivers who preferred median crossovers were over-represented in those who indicated that they do not like the use of barricades, barrels and tubes in WZ.

Unclear and Confusing Signs (Q18): The preference of work zone layout was correlated with the presence of unclear or confusing signs in the Illinois work zones. Drivers who prefer median crossovers or one-lane closure were over-represented in those who mentioned that there are unclear or confusing signs in the Illinois work zones. However, drivers who had no preference in work zone layouts were under-represented in those who said that there are unclear or confusing signs in the work zones.

## Work Zone Features vs Remaining Questions

## Merging to an Open Lane (Q10A) vs Remaining Questions

How comfortable the truck drivers feel about merging to an open lane was correlated with four of the remaining questions in the survey. These questions are the experience of bad driving situations in work zones, directions given by flaggers, the brightness of changeable message boards, and the presence of unclear or confusing signs in the Illinois work zones. Drivers who said that merging to an open lane makes them uncomfortable were over-represented in those who had experienced bad driving situations in work zones, in those who felt that the directions given by flaggers are confusing, in those who felt that changeable message boards are too bright, or in those who saw unclear or confusing signs in the Illinois work zones.

## Median Crossovers (Q10B) vs Remaining Questions

How comfortable the truck drivers feel about median crossovers in work zones was correlated with six of the remaining questions in the survey. These items are the speed limit of 55 mph , the experience of bad driving situations, the visibility of flaggers, the directions given by flaggers, the usefulness of concrete barriers, and the presence of unclear or confusing signs in the Illinois work zones. Drivers who said that they feel uncomfortable when going through median crossovers were over-represented in those who said that the 55 mph speed limit is too slow, in those who had experienced bad driving situations in the work zones, in those who did not like the use of concrete barriers, in those who said that there are unclear or confusing signs in the Illinois construction areas, or those who said that flaggers are very visible. However, they were under-represented in those who said that the directions given by flaggers are usually clear.

The level of discomfort due to lack of shoulders in WZ was correlated with the experience of bad driving situations in work zones, the visibility of flaggers, the directions given by flaggers, the usefulness of tubes, and the presence of unclear or confusing signs. Drivers who said that lack of shoulders makes them uncomfortable were under-represented in those who had experienced bad driving situations or those who said that there are unclear or confusing signs in the Illinois work zones. But drivers who said that lack of shoulders does not makes them uncomfortable were over-represented in those who said that flaggers are very visible or directions given by them are usually clear, and were under-represented in those who said that directions given by flaggers are sometimes confusing or they do not like tubes in work zones.

## Pavement Edge Dropoff (QIOD) vs Remaining Questions

Similar to lack of shoulders, pavement edge dropoff was also correlated with the experience of bad situations in work zones, the use of concrete barrier and tubes, and the presence of unclear or confusing signs in Illinois work zones. Drivers who said that pavement edge dropoff makes them uncomfortable were under-represented in those who had experienced bad driving situations in work zones or those who said that there are confusing or unclear signs in Illinois work zones. Drivers who said that pavement edge dropoff does not makes them uncomfortable were underrepresented in those who do not like the use of concrete barriers or tubes in work zones.

## Loose Construction Materials in the Open Lane (10E) vs Remaining Questions

Loose construction materials in the open lane was correlated with some items of the survey. These items were the 55 mph speed limit in work zones, the use of concrete barriers and tubes, and the presence of unclear or confusing signs in the Illinois work zones. Drivers who answered that loose construction materials do not make them uncomfortable were over-represented in those who said that the 55 mph speed limit is too slow or those who said that concrete barriers are helpful. On the other hand, drivers who said that loose construction materials do not make them feel uncomfortable were under-represented in those who said that tubes are not helpful or those who said that there are unclear or confusing signs in the Illinois work zones.

How uncomfortable the drivers felt due to blowing dirt or dust in the work zones were correlated with the assessment of 55 mph speed limit in work zones, and the brightness of both arrow boards and of changeable message boards. Drivers who answered that blowing dirt or dust does not make them uncomfortable were under-represented in those who said that the 55 mph speed limit is too fast. And they were over-represented in those who indicated that the brightness of arrow boards is okay, but they were under-represented in those who answered that changeable message boards are too bright.

## Lane Width (Q10G) vs Remaining Questions

Lane width discomfort assessment was correlated with the opinions about the 55 mph speed limit in work zones, the experience of bad driving situations, the use of concrete barriers and barricades, the presence of unclear or confusing signs, and the need for adding signs in the Illinois work zones. Drivers who said that lane width does not make them feel uncomfortable were over-represented in those who mentioned that the 55 mph speed limit is too slow or those who liked the use of concrete barriers in work zones. However, they were under-represented in those who had experienced bad driving situations, those who do not like the use of barricades in work zones, those who said that there are unclear or confusing signs in Illinois work zones, or those who said that more signs should be added there.

## Driving in "S" Curves (Q10H) vs Remaining Questions

Drivers who indicated that driving in " S " curves does not make them uncomfortable were overrepresented in those who said that the speed limit of 55 mph in work zones is too slow, those who said flaggers are hard to see, or those who said that there are confusing and unclear signs in the Illinois work zones. On the other hand, they were under-represented in those who replied that flaggers are very visible in work zones, those who do not like the use of concrete barriers or tube in work zones, or those who said that there are unclear or confusing signs in Illinois work zones.

## Lane Closure Taper Length (Q10I) vs Remaining Questions

The assessment of discomfort level of the taper length in lane closure situations was correlated with the opinions on 55 mph speed limit in work zones, use of tubes, the brightness of arrow boards and changeable message boards, and the existence of unclear or confusing signs. Drivers who said the taper length did not make them uncomfortable were over-represented in those who said that the 55 mph speed limit is too slow. Drivers who said the taper length did not make them uncomfortable were under-represented in those who do not like the use of tubes, those who feel that the arrow board or CMB is too bright. However drivers who said the taper length made them uncomfortable were over-represented in those who responded that there are unclear or confusing signs in the Illinois work zones.

## Speed Limit of 55 mph in WZ vs Remaining Questions

Speed Zone of $\mathbf{4 5} \mathbf{m p h}(\mathbf{Q 1 1 B})$ : The opinion on the 55 mph speed limit in work zones was correlated with the travel speed in work zones with the 45 mph speed limit. Drivers who said that the 55 mph speed limit in work zones is too slow were over-represented in those who travel over 45 mph in work zones with 45 mph speed limit. However, drivers who said that speed limit is too fast were under-represented in those who travel over 45 mph in work zones with 45 mph speed limit. Drivers who agreed with the 55 mph speed limit in work zones were overrepresented in those who drive at speeds varying from 46 to 55 mph at the 45 mph speed limit in work zones, but they were under-represented in those who drive at speeds higher than 55 mph at the 45 mph speed limit zones.

Flagger's Directions (Q14B): The perception of the 55 mph speed limit in work zones was correlated with the clarity of directions given by the flaggers. Drivers who said that the 55 mph speed limit in work zones is too slow were under-represented in those who said directions given by flaggers were usually clear, and were over-represented in those who said directions given by flaggers were confusing most of the time.

Height of Changeable Message Boards (Q17A): The perception of the 55 mph speed limit in work zones was correlated with the height of the changeable message boards. Drivers who believe that the 55 mph speed limit is too slow were over-represented in those who indicated that changeable message boards are too low.

## Speed in 45 Zones vs Remaining Questions

Flagger's Visibility (Q14A): The travel speed in work zones with the 45 mph speed limit was correlated with the visibility of flaggers. Drivers who travel below 45 mph were overrepresented in those who said that flaggers are hard to see.

TCD (15B and 15G) : A correlation was found between the travel speed in a WZ with 45 mph speed limit and the helpfulness of barricades and impact attenuators.
Drivers who travel in work zones at $45-50 \mathrm{mph}$ were under-represented in a group who do not like the use of barricades, but drivers who travel at below 45 mph or over 50 mph were overrepresented in that group. Drivers who travel in work zones at 45 mph or below were underrepresented in a group who do not like the use of impact attenuators, but drivers who travel at over 45 mph were over-represented in that group.

## Bad Driving Situations (BDS) anywhere in WZ vs Remaining Questions

This section contains the results of analyses of the responses from the drivers who had experienced bad driving situations regardless of the location of BDS in work zones. The subsequent sections will have the results for the drivers who have experienced BDS in specific work zone areas.

Accidents in WZ (Q13): The experience of bad driving situations in work zones was very closely related to accidents in work zones. Those who had experienced BDS had more accidents in work zones than those who had not.

TCD (Q15A, 15E, and 15F): The experience of bad driving situations in work zones was correlated with three of the seven traffic control devices presented in the survey. Drivers who had experienced BDS in work zones were over-represented in those who did not like the use of cones, barrels, or tubes in WZ.

Brightness of Arrow Boards (16B): The responses to BDS question were correlated to the opinions on brightness of arrow boards. Those who had experienced BDS in work zones were under-represented in those who said arrow boards are too bright.

Height of CMB (17A): The responses to BDS were related to the opinions on the height of
changeable message boards. Those who had experienced BDS in work zones were overrepresented in those who said CMBs are too high.

Additional Sign (Q19): The experience of BDS in work zones was correlated with the need for adding new signs in the Illinois work zones. Drivers who have experience such situations were over-represented in those who said that new signs should be added to the Illinois work zones.

## Accidents in WZ

BDS in WZ (Q12): Accidents in work zones were related to the experience of bad driving situations (BDS) in work zones only. Those who had accidents were over-represented in those who had experienced BDS in work zones.

TCD (Q15C): The experience of accidents in work zones was correlated with the responses to the helpfulness of the white plastic barricades. Those who had accidents were over-represented in those who did not like their use.

## Flagger's Visibility vs Remaining Questions

Flagger's Directions (Q14B): The visibility of flaggers was correlated with the directions given by them to truck drivers. Drivers who said that flaggers are very visible were over-represented in those who said that the directions are very clear. While drivers who said that flagger's visibility is okay were under-represented in those who answered that directions are confusing most of the times, drivers who said flaggers are hard to see were over-represented in that group.

TCD (Q15B, 15F, 15G): The visibility of flaggers was correlated with the opinions on how helpful barricades, tubes, and impact attenuators are. Drivers who said that flaggers are hard to see were over-represented in those who do not like the use of barricades or impact attenuators, but under-represented among those who do not like the use of tubes. Drivers who said the flagger are visible were also under-represented among those who do not like the use of tubes. Drivers for whom impact attenuators are not helpful were under-represented in those who said that flaggers' visibility is okay.

Height and Brightness of Arrow Boards (Q16A and 16B): The opinions on Flagger's visibility in work zones was correlated with those about the height and brightness of arrow boards.

Drivers for whom flaggers were very visible were under-represented in those who answered that arrow boards are too high or too low, or those who answered that arrow boards are too bright. Also, they were over-represented in those who said that the brightness of arrow boards is okay. Drivers for whom flaggers were hard to see were over-represented in those who mentioned that the arrow boards are too high or too low, but they were under-represented in those who answered that the brightness of arrow boards is okay.

Height of Changeable Message Board (Q17A): The height of changeable message boards was found associated with opinions on the visibility of flaggers in work zones. Truck drivers who thought the visibility of flaggers is okay were under-represented in those who answered that the height of changeable message signs is too low. But, drivers who said that flaggers are hard to see were over-represented in those who believed that changeable message signs are too low. It should be noted that only $5 \%$ and $4 \%$ of the respondents said the height is too low or too high, respectively.

Brightness of Changeable Message Board (Q17B): Visibility of flaggers in work zones was correlated with the opinion on brightness of changeable message boards. Drivers who said flaggers are hard to see were over-represented in those who said changeable message boards are too bright or not bright enough.

Unclear and Confusing Signs (Q18): Drivers who indicated that flaggers are very visible or their visibility is okay were under-represented in those who indicated that there are unclear or confusing signs in the Illinois work zones. However, drivers for whom flaggers are hard to see were over-represented in those who mentioned the presence of unclear or confusing signs in Illinois work zones.

Additional Signs (Q19): The need for adding signs to the Illinois work zones was also found correlated with the opinion on visibility of flaggers in work zones. Drivers who said that flaggers are very visible were under-represented in those who mentioned that signs should be added to work zones. However, drivers who said flaggers were hard to see were overrepresented in those who indicated the need for more signs in the Illinois work zones.

## Flagger's Directions vs Remaining Questions

TCD (Q15A, 15C, 15D, 15E, 15F, 15G): The opinions about the directions given by flaggers were correlated with the traffic control devices such as cones, white plastic barricades, concrete
barriers, barrels, tubes, and impact attenuators. First, drivers who said that directions given by flaggers are usually clear were under-represented in those who indicated that they don't like the use of cones, white plastic barricades, concrete barriers, barrels, tubes, or impact attenuators. Drivers who answered that directions given by flaggers are confusing most of the time were over-represented in those who mentioned that those six traffic control devices are not helpful. Specifically, drivers who said that directions are sometimes confusing were under-represented in those who pointed out that tubes are also not helpful.

Height of Arrow Board(Q16A): The opinions about directions given by flaggers were correlated with the height of arrow boards. Drivers who said the directions given by flaggers are usually clear were under-represented in those who mentioned that arrow boards are too low. Drivers who said that directions are most of the times confusing were over-represented in those who indicated that arrow boards are either too low or too high. And they were under-represented in those who indicated that the height is okay.

Brightness of Arrow Board(Q16B): The opinions about directions given by flaggers were correlated with the opinions on brightness of arrow boards. Drivers for whom directions given by flaggers are confusing most of the time were under-represented in those who mentioned that the brightness of arrow boards is okay.

Height and Brightness of Changeable Message Boards (Q17A and 17B): The responses for both height and brightness of changeable message signs were correlated with the responses on directions given by flaggers in work zones. Drivers who said directions are sometimes confusing were under-represented in those who said that changeable message signs are too low, and they were over-represented in those who indicated that changeable message signs are not bright enough. Within the category of drivers who think that directions given by flaggers in work zones are most of the times confusing, those who mentioned that changeable message signs are too low or too bright were over-represented. And they were under-represented in those who think that the brightness is okay. Finally, drivers who see directions given by flaggers as very clear were over-represented in those who said the brightness of changeable message signs is not enough.

Unclear and Confusing Signs (Q18): Drivers who believe that directions given by flaggers are usually clear were under-represented in those who indicated that there are unclear or confusing signs in the Illinois work zones. Drivers who said that directions are most of the times confusing were over-represented in those who noticed the existence of unclear or confusing signs in the Illinois work zones.

Additional Signs (Q19): Drivers who said that directions given by flaggers are confusing (both sometimes and most of the times) were over-represented in those who mentioned that signs should be added to the Illinois work zones.

## Barricades (Q15B) vs Remaining Questions

Height and Brightness of Arrow Boards (16A and 16B): The opinions on helpfulness of barricades was correlated with the assessment of the brightness and height of arrow boards. Drivers who do not like the use of barricades were over-represented in those who mentioned that arrow boards are too high, and they were under-represented in those who indicated that the brightness of arrow boards is okay.

## Concrete Barriers (Q15D) vs Remaining Questions

Height and Brightness of Arrow Boards (Q16A and 16B): The perception of helpfulness of concrete barriers was correlated with the opinions on brightness and the height of arrow boards. Drivers who perceived the concrete barriers as helpful were under-represented in those who said the arrow boards are either too low or too high. And drivers who do not like their use in work zones were under-represented in those who indicated that the brightness of arrow boards is okay. Contrary to that, drivers who said that concrete barriers are not helpful were over-represented in those who indicated that the height of arrow boards is either too low or too high. Finally, drivers for whom concrete barriers are helpful were also under-represented in those who mentioned that arrow boards brightness is okay.

Brightness of Changeable Message Boards (Q17B): Drivers who like the use of concrete barriers in work zones were under-represented in those who indicated that changeable message signs are too bright. However, drivers who said that concrete barriers are not helpful were overrepresented in those who said that changeable message signs are also too bright.

Confusing and Unclear Signs (Q18): The opinions on the use of concrete barriers in work zones was correlated with the presence of unclear or confusing signs in the Illinois work zones. Drivers who like concrete barriers were under-represented in those who responded that there are confusing and unclear signs in work zones. On the other hand, drivers who do not see concrete barriers as helpful traffic control devices in work zones were over-represented in them.

Additional Signs (Q19): Drivers who like concrete barriers were under-represented in those who responded that new signs should be added to WZ. On the other hand, drivers who do not see concrete barriers as helpful traffic control devices in work zones were over-represented in them.

## Barrels (Q15E) vs Remaining Questions

Height of Arrow Boards (Q16A): The perception of usefulness of barrels were correlated with the opinions on height of arrow boards. Drivers who answered that barrels are not helpful were over-represented in those who think arrow boards as either too high or too low, and they were under-represented in those who said that their height is okay.

Brightness of Changeable Message Boards (Q17B): Drivers who thought that barrels are helpful were under-represented in those who thought that changeable message signs are too bright.

Unclear and Confusing Signs (Q18): The perception of usefulness of barrels in work zones was also correlated with opinions on confusing or unclear signs. Drivers who do not like the presence of barrels were over-represented in those who mentioned that there are confusing or unclear signs in the Illinois work zones.

## Impact Attenuators (Q15G) vs Remaining Questions

Height of Arrow Board (Q16A): The opinions on the usefulness of impact attenuators were correlated with those about the height of arrow boards. Drivers who answered that impact attenuators are not helpful were over-represented in those who think that arrow boards are too high.

Brightness of Changeable Message Boards (Q17B): Perception of the usefulness of impact attenuators were also correlated with the opinions on the brightness of changeable message boards. Drivers who did not like the use of impact attenuators were over-represented in those who think that changeable message boards are not bright enough.

Unclear or Confusing Signs (Q18): The usefulness of impact attenuators were correlated with opinions on confusing or unclear signs in work zones. Drivers who did not like the use of impact attenuators were over-represented among those who said that such signs exist in Illinois work

## Height of Arrow Boards vs Remaining Questions

Brightness of Arrow Board (Q16B): The drivers responses on the height of arrow boards was highly correlated with what they think about their brightness. Drivers who thought arrow boards were too high or too low were over-represented in those who indicated that arrow boards are too bright. Among drivers who considered the brightness of arrow boards okay, drivers who saw the height of arrow boards as okay were over-represented.

Height of Changeable Message Board (Q17A): The opinions on the height of arrow boards and changeable message signs were also found correlated with each other. Drivers who think arrow boards are too low were over-represented in those who have the same opinion about changeable message signs. Drivers who believe that the height of arrow boards is okay were underrepresented in those who mentioned that changeable message signs is too low.

Unclear and Confusing Signs (Q18): Drivers who said that arrow boards are either too high or too low were over-represented in those who indicated that there are unclear or confusing signs in the Illinois work zones. And drivers who see arrow boards' height as okay were underrepresented among those who said such signs exists in WZ.

## Brightness of Arrow Boards vs Remaining Questions

Brightness of Changeable Message Board (Q17B): The opinions on the brightness of arrow boards and the brightness of changeable message signs were also found correlated. Drivers who said arrow boards are too bright were over-represented in those who said that changeable message signs are too bright. However, drivers who responded that the brightness of arrow boards is okay were under-represented in those who said that changeable message signs are too bright.

Unclear or Confusing Signs (Q18): Drivers who see the brightness of arrow boards as okay were under-represented in those who indicated that there are unclear or confusing signs in the Illinois work zones.

Additional Signs (Q19): Drivers who said the arrow boards' brightness was okay were underrepresented in those who indicated that new signs should be added to WZ.

## Height of Changeable Message Signs vs Remaining Questions

Brightness of Changeable Message Board (Q17B): As expected, the opinions on the height of changeable message signs were also correlated with those about their brightness. Drivers who said that changeable message signs are too low were over-represented in those who also indicated that they are not bright enough. And drivers who indicated that the height is okay were under-represented in those who also said that they are not bright enough.

## Brightness of Changeable Message Boards vs Remaining Questions

Unclear and Confusing Signs (Q18): The perception of brightness of changeable message signs was found correlated with the opinions of existence of unclear or confusing signs in work zones. Drivers who think that changeable message boards are too bright were over-represented in those who mentioned that there are confusing or unclear signs in the Illinois work zones. On the other hand, drivers who see the brightness of changeable message signs as okay were underrepresented in that group.

## Unclear or Confusing Signs vs Remaining Questions

Additional Signs (Q19): The opinions on the presence of unclear or confusing signs in the Illinois work zones was correlated with the need for adding new signs to construction areas. Drivers who said that there are unclear or confusing signs in the Illinois work zones were underrepresented in those who indicated that new signs should be added to them.

## Additional WZ Signs vs Remaining Questions

Drove in IL WZ (Q20): Drivers who said signs should be added to work zones were underrepresented among those who did not drive through a work zone in Illinois.

## Drove through Illinois WZ vs Others

Any significant relationship between question 20 and all other questions (question 1-19) are explained in the previous part of this Chapter. This question was included to check whether the
participants have traveled through an Illinois work zone that day. Since $94 \%$ of the participants had traveled through an Illinois WZ that day, it was decided to use the entire sample for further analysis.

## Suggestions to improve WZ vs Other Questions

(This part of the analysis considered two types of drivers- those who made suggestions and those who did not. Then, correlation analyses were conducted to see if there was significant relationships between the opinions about the presence of a suggestion and the other questions.)

4a: Drivers who made suggestions were over-represented in those who drove box vans, but they were under-represented in those who drove dump or special purpose trucks.

Time of Travel (Q5) : Drivers who travel during daytime were under-represented in those who made suggestions.

Advance WZ signs (Q7): Drivers who wanted to know about a work zone less than 1 mile in advance were under-represented in those who made suggestions. And drivers who would like to see work zone signs $3-5$ miles in advance were over-represented in those who made suggestions.

Hazard of WZ (Q8): Drivers who felt work zones are same as non-work zones in hazardousness were under-represented in those who presented suggestions.

TCD (Q10E and 10G): Drivers who said loose construction materials in the open lane or lane width do not make them feel uncomfortable were under-represented in those who made suggestions.

WZ Speed (Q11A and 11B): Drivers who believe that 55 mph speed limit in work zones is too low or travel at 45 mph in work areas of 45 mph limit were under-represented in those who presented suggestions.

BDS (Q12): Drivers who have experienced bad situations in work zones were over-represented in those who provided suggestions.
(Flagger's Visibility 14A): Drivers who think that flaggers in work zones are very visible were under-represented in those who made suggestions.

Brightness of Changeable Message Boards (Q17B): Drivers who said that changeable message signs are too bright or not bright enough were under-represented in those who made suggestions.

Unclear/Confusing Signs or Additional Signs in WZ (Q18 and 19): Drivers who indicated that there are unclear or confusing signs in the Illinois work zones or that signs should be added to them were over-represented in those who provided suggestions.

Drove in Illinois WZ (Q20): Drivers who had traveled through a work zone in Illinois on the day of the survey were under-represented in those who made suggestions.

Comments about WZ (Q22): Drivers who made extra comments were also under-represented in those who provided suggestions to make Illinois work zones better.

## Comments made vs Other Questions

Like Question 21, this part of the analysis considered two types of drivers- those who provide extra comments and those who did not. Then, correlation analyses were conducted to see if there was significant correlations between those who offered comments and the responses to other questions.

Time of Driving (Q5): Drivers who drive only during daytime were under-represented in those who made comments.

Lane Width (Q10G): Drivers who said the WZ lane width does not make them feel uncomfortable were under-represented in those who made comments.

Speed Limit of 55 MPH (Q11A): Drivers who said that the 55 mph speed limit in work zones is too low were under-represented in those who made comments.

BDS (Q12): Drivers who have experienced bad situations in work zones were over-represented in those who presented comments.

TCD (Q15D and 15E): Drivers who said that they do not like the use of concrete barriers or barrels in work zones were over-represented in those who provided comments.

Height of Arrow Board (Q16A): Drivers who think arrow boards are too high were over-
represented in those who made comments. However, drivers who agree with their height were under-represented in the group.

Brightness of Changeable Message Board (Q17B): Drivers for whom changeable message signs are not bright enough were over-represented in those who made comments.

Unclear/Confusing Signs and Additional Signs (Q18 and 19): Driver who said that there are confusing or unclear signs in the Illinois work zones, or that new signs should be added to them were over-represented in those who provided comments.

Drove in Il WZ (Q20): Drivers who traveled through a work zone in Illinois on the survey's day were under-represented in those who made comments.

TABLE 6.2 Results of F-test (Q.1, 2A, 2B and 3 vs. all others)

|  | 0.1 | Q.2A | Q. 28 | 0.3 |
| :---: | :---: | :---: | :---: | :---: |
| 4 a | Y | Y | $Y$ | $Y$ |
| 4 b | . | Y | $Y$ | - |
| 5 | - | Y | $Y$ | . |
| 6 | - | - | - | - |
| 7 | $Y$ | - | - | $Y$ |
| 8 | Y | - | - | - |
| 9 | Y | $Y$ | . | Y |
| 10A | - | $Y$ | - | $Y$ |
| 10 B | Y | Y | Y | - |
| 10 C | Y | $\gamma$ | - | - |
| 100 | Y | . | . | - |
| 10E | Y | - | - | $Y$ |
| 10F | - | Y | - | Y |
| 10 G | Y | $Y$ | - | - |
| 10H | $y$ | - | - | - |
| 10 I | - | - | - | Y |
| 11a | Y | $Y$ | $y$ | Y |
| 110 | Y | Y | $Y$ | $y$ |
| 12 | - | - | - | - |
| 13 | - | - | Y | - |
| 14a | Y | Y | - | $Y$ |
| 14b | - | - | - | . |
| 15A | - | - | - |  |
| 158 | - | - | - | - |
| 150 | - | - | - | - |
| 150 | Y | - | Y | Y |
| 15E | - | - | - | - |
| 15F | - | - | - | - |
| 156 | Y | . | - | Y |
| 16a | - | $Y$ | - | - |
| 16b | Y | - | $Y$ | Y |
| 17a | . | - | - | - |
| 17b | - | - | - | - |
| 18 | Y | - | - | $Y$ |
| 19 | . | Y | - | - |
| 20 | - | - | - | - |
| 21 |  |  |  |  |
| 22 |  |  |  |  |

Note: Y (Significant at $90 \%$ confidence level). - (Not significant at $90 \%$ confidence level)

TABLE 6.3 Results of $\chi^{2}$-Goodness-of-Fit Test

| 1 | 4 a | 4b | 5 | 6 | 7 | 8 | 9 | 10A | 108 | 10 C | 100 | 1.0 E | 10 F | 10G | 10 H | 101 | 112 | 116 | 12 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 4 a |  | $Y$ | $Y$ | $Y$ | - | . | - | $Y$ | . | . | - | $Y$ | - | $Y$ | $y$ | $Y$ | $Y$ | $Y$ | $Y$ |
| 4 b | Y |  | - | - | Y | Y | - | - | - | . | - | - | - | - | - | - |  |  | $Y$ |
| 5 | $Y$ | - |  | Y | - | - | - | Y | Y | - | . | $Y$ | - | Y | - | - | $Y$ |  |  |
| 6 | $Y$ | - | Y |  | - | - | - | Y | Y | - | - | Y | - | Y | . | . | Y | - | - |
| 7 | - | Y | - | - |  | - | - | - | - | - | - | - | - | Y | . | - | . | - | - |
| 8 | - | $Y$ | . | - | - |  | Y | Y | Y | Y | Y | - | - | $Y$ | Y | $\checkmark$ | - | - | Y |
| 9 | - | - | - | - | - | Y |  | $Y$ | $y$ | $\gamma$ | $Y$ | Y | Y | Y | $Y$ | $Y$ | - | - | - |
| 10A | $Y$ | - | $Y$ | - | - | Y | $y$ |  |  |  |  |  |  |  |  |  | - | $Y$ | - |
| 10B | - | - | $Y$ | - | - | Y | $Y$ |  |  |  |  |  |  |  |  |  | $Y$ | - | $Y$ |
| 100 | - | - | - | - | - | $Y$ | Y |  |  |  |  |  |  |  |  |  | - | - | $Y$ |
| 100 | - | - | - | - | - | Y | $Y$ |  |  |  |  |  |  |  |  |  | - | - | Y |
| IOE | $Y$ | - | Y | - | - | - | $Y$ |  |  |  |  |  |  |  |  |  | $y$ | - | - |
| 10F | . | - | - | - | - | - | $Y$ |  |  |  |  |  |  |  |  |  | Y | - | - |
| 10G | $\gamma$ | - | Y | . | Y | Y | $Y$ |  |  |  |  |  |  |  |  |  | Y | - | Y |
| 10 H | $y$ | - | - | . | - | $Y$ | $Y$ |  |  |  |  |  |  |  |  |  | Y | - | - |
| 101 | Y | - | - | - | - | $Y$ | $Y$ |  |  |  |  |  |  |  |  |  | $Y$ | - | - |
| 11 a | $y$ | - | Y | - | - | - | - | - | $Y$ | - | - | Y | $Y$ | Y | Y | Y |  | $Y$ | - |
| 11b | $Y$ | - | - | - | - | - | - | - | - | - | - | - | - | - | - | . | Y |  | - |
| 12 | $Y$ | $Y$ | - | - | - | $y$ | - | $Y$ | $Y$ | $Y$ | Y | - | - | Y | - | - | - | - |  |
| 13 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | . | - | . | $\gamma$ |
| $14 a$ | Y | - | - | - | $Y$ | - | - | - | Y | Y | - | - | - | - | $Y$ | . | - | $Y$ | - |
| 14b | - | Y | - | - | - | - | - | $y$ | Y | Y | - | . | - | - | - | - | Y | - | - |
| 15A | . | - | - | - | - | - | - | - | - | - | . | - | - | - | . | . | - | - | $\gamma$ |
| 158 | . | - | - | - | - | - | $Y$ | - | - | - | - | - | - | Y | - | - | - | $Y$ | - |
| 15 C | - | - | - | - | - | - | - | - | - | - | - | - | - | - | . | - | - | - | . |
| 150 | $Y$ | $Y$ | $Y$ | - | - | - | - | - | Y | - | Y | Y | - | $Y$ | Y | - | - | - | - |
| 15E | - | - | - | - | - | - | $\gamma$ | - | . | - | - | - | - | - | - | - | - | - | Y |
| 15F | - | - | - | - | - | - | Y | - | - | $Y$ | $Y$ | $Y$ | - | - | Y | Y | - | - | Y |
| 15G | - | - | - | . | - | - | - | - | - | . | - | - | - | - | - | . | - | Y | - |
| 16a | - | . | $y$ | $Y$ | - | - | - | . | . | - | - | - | - | - | - | - | . | - | - |
| 15b | - | $\gamma$ | Y | - | Y | - | - | - | - | - | . | - | Y | . | - | Y | - | - | $Y$ |
| 17a | - | - | - | - | - | - | - | . | - | - | - | - | - | - | - | - | Y | - | $Y$ |
| 17b | - | $Y$ | - | - | - | . | - | $Y$ | - | - | - | - | Y | - | - | Y | - | - | - |
| 18 | - | - | - | - | - | . | $Y$ | $Y$ | Y | $Y$ | $Y$ | Y | - | $Y$ | Y | Y | - | - | - |
| 19 | - | - | Y | $\gamma$ | - | $\gamma$ | - | . | - | - | - | - | - | $Y$ | - | - | - | - | Y |
| 20 | - | - | - | . | - | - | - | . | - | - | - | - | - | - | - | - | - | - | - |
| 21 | Y | - | $Y$ | - | Y | $Y$ | . | $Y$ | - | - | $Y$ | $Y$ | - | $Y$ | - | - | Y | $Y$ | Y |
| 22 | - | - | $Y$ | - | $Y$ | - | - | - | - | - | - | - | - | $Y$ | - | - | $Y$ | - | $Y$ |

Table 6.3 (Continued)

| 1 | 13 | 14 a | 14b | 15A | 158 | 150 | 150 | $15 E$ | 15F | L5G | 15a | 16b | 172 | 17b | 18 | 19 | 20 | 21 | 22 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 4 a | - | Y | - | - | - | - | $Y$ | . | - | - | . | - | - | . | - | - | . | Y | - |
| 4 b | - | $Y$ | Y | - | - | - | Y | . | - | - | - | $y$ | - | $y$ | - | . | . | - | - |
| 5 | - | - | - | - | - | - | Y | - | - | - | $Y$ | $Y$ | - | - | - | - | - | Y | $Y$ |
| 6 | - | - | - | - | - | . | Y | - | - | . | $y$ | $Y$ | - | - | . | Y | - | - | - |
| 7 | - | $Y$ | - | - | - | - | - | - | - | . | . | $Y$ | - | - | - | - | - | $Y$ | Y |
| 8 | - | . | - | - | - | - | - | - | - | - | . | . | - | - | - | Y | - | $Y$ | - |
| 9 | - | - | - | - | Y | - | - | $Y$ | $Y$ | . | . | . | - | - | $Y$ | - | . | - | - |
| 10A | - | - | $Y$ | - | - | - | - | - | - | - | . | - | - | 9 | Y | - | - | $Y$ | - |
| 108 | - | - | - | - | - | - | $Y$ | - | - | . | - | - | - | - | Y | . | - | $Y$ | - |
| 100 | - | $Y$ | $Y$ | . | - | - | $y$ | . | $Y$ | . | . | - | . | - | $Y$ | - | - | - | - |
| 100 | - | - | - | - | - | - | - | . | - | . | - | - | . | - | $Y$ | - | - | $Y$ | $Y$ |
| 10 E | - | - | - | - | . | - | $y$ | . | $Y$ | - | - | . | - | - | Y | - | . | . | . |
| 10F | - | - | - | . | - | - | - | . | - | . | . | Y | . | Y | . | - | - | - | . |
| 10G | - | - | - | - | $Y$ | - | $Y$ | - | - | . | - | - | - | - | $y$ | Y | - | . | Y |
| 10 H | - | $Y$ | - | - | - | - | Y | - | $Y$ | - | . | . | . | - | $\gamma$ | - | - | - | - |
| 10 I | - | - | - | - | - | - | - | - | $Y$ | - | - | $Y$ | - | $Y$ | $Y$ | - | - | - | - |
| 11 a | - | - | $Y$ | - | - | . | . | - | - | - | - | - | $Y$ | - | - | - | - | $\gamma$ | Y |
| 11b | - | $Y$ | - | - | $Y$ | $y$ | - | - | - | Y | . | - | - | . | - | - | - | $Y$ | - |
| 12 | $Y$ | . | - | $Y$ | - | - | - | $\gamma$ | $\gamma$ | - | - | Y | Y | - | - | Y | - | $Y$ | $Y$ |
| 13 |  | - | - | - | - | $Y$ | - | . | - | - | - | . | - | . | - | - | . | - | - |
| 14a | - |  | $Y$ | - | $Y$ | - | - | - | $Y$ | $\gamma$ | $Y$ | Y | Y | Y | Y | $\gamma$ | - | $Y$ | - |
| 14b | - | $Y$ |  | $Y$ | - | Y | Y | $Y$ | Y | $Y$ | $Y$ | $Y$ | $y$ | $Y$ | Y | $\gamma$ | - | - | . |
| 15A | . | . | $Y$ |  |  |  |  |  |  |  | - | - | - | - | . | - | - | - | - |
| 15B | - | $y$ | - |  |  |  |  |  |  |  | Y | Y | - | - | - | - | - | - | - |
| 15C | $Y$ | - | $Y$ |  |  |  |  |  |  |  | - | - | - | - | - | - | - | - | - |
| 150 | - | - | $Y$ |  |  |  |  |  |  |  | $Y$ | $y$ | - | $Y$ | $Y$ | Y | - | $\gamma$ | $Y$ |
| 15E | - | - | $Y$ |  |  |  |  |  |  |  | $Y$ | - | . | $Y$ | $Y$ | - | - | . | Y |
| 15 F | - | $y$ | $y$ |  |  |  |  |  |  |  | . | - | - | - | . | - | - | - | - |
| 15G | - | Y | $Y$ |  |  |  |  |  |  |  | $y$ | . | . | Y | $Y$ | - | - | - | - |
| 16a | - | $Y$ | $Y$ | . | $Y$ | - | Y | Y | - | $Y$ |  | $Y$ | $Y$ | - | $Y$ | - | - | - | $Y$ |
| 16b | - | Y | $Y$ | - | $Y$ | . | $Y$ | - | - | - | $Y$ |  | . | Y | Y | Y | . | - | - |
| 17a | - | $Y$ | $Y$ | - | - | - | - | - | - | - | Y | - |  | Y | - | - | . | $Y$ | Y |
| 176 | - | $Y$ | $Y$ | - | - | - | $Y$ | Y | - | $Y$ | . | $Y$ | Y |  | $Y$ | - | . | $Y$ | Y |
| 18 | - | Y | Y | - | - | - | $Y$ | $Y$ | - | Y | $y$ | $Y$ | - | Y |  | $y$ | - | $Y$ | $Y$ |
| 19 | - | $Y$ | $Y$ | - | - | - | Y | - | - | - | - | Y | - | - | Y |  | Y | Y | $Y$ |
| 20 | - | Y | - | - | . | - | . | - | - | . | - | - | - | - | - | $Y$ |  | $Y$ | $Y$ |
| 21 | - | Y | - | - | - | - | $Y$ | - | . | - | . | - | - | Y | Y | $Y$ | Y |  | $Y$ |
| 22 | - | - | - | . | - | - | $Y$ | $Y$ | . | - | Y | . | - | $Y$ | Y | $Y$ | $Y$ | $Y$ |  |



To find correlation between a question versus all other questions (for example, question 12 versus other questions), one needs to look at the row or the column for that question. The below figure shows how to find them.


Correlation analysis in Chapter 6 is based on the lower triangle. For example, to know the correlations of question 12 with the others, one should look at the correlations between question 12 and questions 1 through 11 , then look at correlations between questions 13 through 22 with question 12 .

## CHAPTER 7

## FINDINGS ABOUT CONCERNED ITEMS

In Chapters 4 and 6, the frequency analysis and correlation analysis of the survey questions were discussed. In this chapter, correlation of travel characteristics to certain questions in the survey, which are identified as concerned items, will be discussed. These concerned items are: load permit, hazard assessment, speed limits of 55 and 45 mph , flaggers' visibility and directions, height and brightness of arrow boards (see Charts 7.1-7.8).

## Load Permit

Drivers were asked if they were carrying any type of permit(s) at the survey time. About $79 \%$ said that they were not holding any type of permit, but $15 \%$ were carrying hazardous materials permits and $5 \%$ had over-dimension related permits. About $1 \%$ had both hazardous materials and over-dimension related permits. When correlation analyses were conducted, the permit type was found to be correlated to truck types, driving time, height of arrow boards, and the need to add signs to work zones.

Drivers who were carrying hazardous material related permits were over-represented in those who drove tanker or chemical trucks, who felt arrow boards are too high, or who felt that additional signs are needed in work zones. However, they were under-represented in those who usually drove trucks daytime, or who felt the height of arrow boards is okay.

Drivers who were carrying over-dimension related permits were over-represented in those who drove flatbed or lowboy trucks, who usually drove daytime, or who said additional signs should be added to work zones.

## Hazard Assessment

Drivers were asked to compare the hazard of driving through work zones to non-work zones. About $90 \%$ answered that work zones are more hazardous than non-work zone areas, and only $8 \%$ and $1 \%$ said that work zones are the same and less hazardous than non-work zones, respectively.

Hazard assessment were correlated to driving experience, carrier type, preference of work zone layout, uncomfortable feelings about 7 work zone features (merging to an open lane, median crossovers, lack of shoulders, pavement edge dropoff, lane width, driving in " S " curves, lane closure taper length), experience of bad driving situations, need to add signs to work zones.

Drivers who assessed traveling through work zones more hazardous than non-work zones were over-represented in those who prefer one-lane closure to median crossover, who feel uncomfortable in the above 7 work żone features, or who have experienced bad driving situations. But they were under-represented in those who do not have a preferred work zone layout. Their average driving experience ( 15.8 years) was lower than those drivers who said the hazard of traveling is the same (18.6 years).

Drivers who assessed the hazard of traveling through work zones to be about the same as non-work zones were over-represented in those who drive trucks for common carriers. However they were under-represented in those who drive trucks for private carriers, who feel uncomfortable in the above 7 work zone features, who have experience in bad driving situations in work zones, or who said no need to add signs to work zones.

## Speed Limit of $55 \mathbf{m p h}$

Drivers' opinions were asked about 55 mph speed limit in work zones. About $62 \%$ answered that such a speed limit is about right, $25 \%$ said that it is too fast, $9 \%$ responded that it is too slow, and $4 \%$ made no responses. It should be noted that the speed limit on Illinois interstate work zones is 55 mph , unless a 45 mph speed limit is put into effect. When workers are present, regulatory 45 mph speed limits are activated by turning on the two yellow strobe lights mounted on the speed limit signs.

The assessment of 55 mph speed limit in work zones was correlated to the responses to driving experience, miles driven in both U.S. and Illinois, age of drivers, truck types, driving time, six work zone features (median crossovers, loose construction materials, blowing dirt or dust, lane width, driving in " S " curves, and lane closure taper length), driving speed in work zones with 45 mph speed limit, directions given by flaggers, and height of changeable message boards.

Truckers who said that the 55 mph speed limit is too fast had more driving experience than the others (too low or about right). They drove more in Illinois than those who said that the speed limit is too slow, and they were older than the ones who said it is too low or about right. Drivers who said that the speed limit is too fast were over-represented in those who drove double bottoms.

Drivers who said the speed limit is about right drove more in U.S. than those who said that speed limit is too slow. Drivers who said it is about right were over-represented in box van drivers. They were under-represented among those who stated that they usually drive in daytime. Drivers who agreed with the 55 mph speed limit were over-represented among those who drive at speeds varying from 46 to 55 mph , but were under-represented in those who drive at speeds higher than 55 mph in work zones with a 45 mph speed limit.

Drivers who said it is too slow were over-represented among those who drive specialpurpose trucks, drive usually in daytime, feel uncomfortable due to the above six work zone features, or travel over 45 mph in work zones with a 45 mph speed limit. Drivers who said that the 5.5 mph speed limit in work zones is too slow were also over-represented in those who said the height of changeable message boards is too low, and in those who said directions given by flaggers are confusing most times.

## Speed Limit of $\mathbf{4 5} \mathbf{~ m p h}$

Drivers were asked to indicate how fast they drive in a work zone with 45 -mph speed limit. The highest proportion ( $34 \%$ ) was found for those driving at the range $46-50 \mathrm{mph}$, followed by those driving at $45 \mathrm{mph}(30 \%)$. However, relatively high percentages were found at the ranges below $45 \mathrm{mph}(19 \%)$ and 51 mph and over ( $17 \%$ ). Thus, in a 45 mph speed zone, nearly half ( $49 \%$ ) of the drivers said they drove at or below the speed limit, and the other half exceeded it.

Driving speed in 45 mph speed limit was correlated to driving experience, miles driven in both U.S. and Illinois, age of drivers, type of trucks, 55 mph speed limit, flaggers' visibility, and helpfulness of barricades and impact attenuators. Driving speed at the $45-\mathrm{mph}$ speed limit and feeling about $55-\mathrm{mph}$ speed limit in work zones were closely related to each other (see the above section "speed limit of 55 mph ").

Drivers who drove at speeds of 51 mph and over in work zones with the 45 mph speed limit had less driving experience than the others. Drivers who drove at speeds of 56 mph and over had more miles driven in U.S. while drivers who drove less than 45 mph had more miles driven in Illinois. Driver who drove at speeds of 51 mph and over were younger than the other groups. They were over-represented in driving box vans and were under-represented in driving double bottom trucks. Drivers who drove at speeds of 51 mph and over were over-represented in those who don't like the use of barricades or impact attenuators.

Drivers who drove at speeds of $46-50 \mathrm{mph}$ in work zones with the 45 mph speed limit were over-represented in those who said 55 mph speed limit is about right, and were underrepresented on those who said the 55 mph is too fast.

Drivers who drove at speed of 45 mph were under-represented among those who don't like the use of barricades or impact attenuators. They were over-presented in those who said that flaggers are hard to see.

## Visibility of Flaggers

About $44 \%$ of the drivers said that flaggers' visibility in work zones is okay, and about
$19 \%$ said that flaggers are very visible. However, $32 \%$ said that flaggers are hard to see. When compared to other questions, the responses to flaggers' visibility were correlated to the followings items: driving experience, miles driven in U.S., age of driver, truck types, advanced signs about work zones, lack of shoulders, driving in "S" curves, speed limit of 45 mph , directions given by flaggers, helpfulness of barricades, tubes and impact attenuators, height and brightness of arrow boards and changeable message boards, confusing signs, and need of additional signs to work zones.

Drivers who said flaggers are hard to see had more driving experience, were older, or had driven more miles in U.S. than others. Furthermore, drivers who said flaggers are hard to see were over-represented among those who drove flatbeds or platforms trucks, wanted to know about work zones 5 miles or more in advance, drove at speeds below 45 mph in work zones with $45-\mathrm{mph}$ speed limit, thought the flagger's directions are confusing most of the times, did not like the use of barricades and impact attenuators, mentioned that the arrow boards are too high or too low, said changeable message boards are too low, said changeable message boards are too bright or not bright enough, mentioned the presence of unclear or confusing signs in WZ , or indicated the need for more signs in the Illinois work zones. On the other hand, drivers who said that flaggers are hard to see were under-represented in those who did not like the use of tubes, or indicated that the brightness of arrow boards is okay.

Drivers who said flagger's visibility is okay were under-represented in those who stated that flagger's directions are confusing most of the times, thought that impact attenuators are not helpful, said the height of changeable message signs is too low, or indicated that there are unclear or confusing signs in the Illinois work zones.

Drivers who said flaggers are very visible were over-represented in those who drove double bottoms, wanted to know about work zones 1 miles or less in advance, did not feel uncomfortable due to the lack of shoulders, said that flagger's directions are very clear, or said the brightness of arrow boards is okay. However, drivers who said flaggers are very visible were under-represented in those who drove flatbed or platform trucks, did not like the use of tubes, felt uncomfortable driving in " $S$ " curves, responded that arrow boards are too high or too low, answered that arrow boards are too bright, indicated that there are unclear or confusing signs in WZ, or mentioned that more signs need to be added to work zones.

## Directions Given by Flaggers

While nearly half of drivers ( $46 \%$ ) thought that directions given by flaggers are usually clear, another half of drivers ( $49 \%$ ) said that directions are confusing most of the times or sometimes. The responses to this item were correlated to other questions such as type of carriers, merging to open lanes, lack of shoulders, $55-\mathrm{mph}$ speed limit, flaggers' visibility,
usefulness of several TCDs (cones, white plastic barricades, concrete barriers, barrels, tubes, and impact attenuators), height and brightness of arrow boards and CMB, confusing signs, and the need to add signs to work zones.

Drivers who said directions given by flaggers were confusing most of times were overrepresented in those who drove for private carriers, felt uncomfortable in merging to an open lane, said speed limit of 55 mph is too slow, did not like the use of the TCDs (cones, white plastic barricades, concrete barriers, barrels, tubes, or impact attenuators), thought arrow boards are too low or too high, said brightness of arrow boards is okay, replied that CMB height is too low, felt CMB is too bright, noted that unclear or confusing signs exist in WZ, or wanted more signs in WZ. However, they were under-represented among the drivers who said flagger's visibility is okay or the height of arrow board is okay.

Drivers who responded that the flagger's directions were sometimes confusing were overrepresented among those who felt uncomfortable in merging to an open lane, thought the height of CMB is too low, CMB are not bright enough, or wanted more signs added to WZ. However, they were under-represented among those who said the lack of shoulders in WZ did not make them feel uncomfortable.

Drivers who indicated that the flagger's directions were usually clear were underrepresented among those who worked for private carriers, felt uncomfortable in merging to an open lane, said the 55 mph speed limit in WZ is too slow, did not like the use of those six TCD, thought the height of arrow boards is too low, or replied that unclear or confusing signs exist in WZ. However, they were over-represented among drivers who said the flaggers were very visible or CMB were not bright enough.

## Height of Arrow Boards

Nearly three quarters of the surveyed drivers ( $76 \%$ ) said the height of arrow board is okay. However, $15 \%$ said it is too high and $5 \%$ too low. About $4 \%$ expressed no opinions on the matter. The responses to this item were correlated to other questions such as miles driven in U.S., driving time, permit types, flaggers' visibility and directions given by them, usefuiness of several TCDs (barricades, concrete barriers, barrels, and impact attenuators), brightness of arrow boards, height of CMB, and confusing/unclear signs in work zones. Drivers who said that arrow boards are too low drove more than those who indicated that the height is okay.

Driver who said it is too high were over-represented among those who had hazmat permits, said flaggers are hard to see or their directions are most of the time confusing, did not like the use of those four TCD, said arrow boards are too bright, or unclear or confusing signs exist in WZ. However, they were under-represented among those who usually drive in daytime or said flaggers are very visible.

Drivers who indicated that the height is okay were under-represented among drivers who had hazmat permits, felt directions given by flaggers were most of the time confusing, said CMB height is too low, or indicated that unclear or confusing signs exist in WZ. On the other hand, a higher proportion of drivers who said the height of arrow boards is okay also indicated that their brightness is okay.

Finally, a higher proportion of drivers who said the arrow boards' height is too low indicated that flaggers are hard to see, the directions are most of the time confusing, CMB are too low, or there were unclear or confusing signs in the WZ. However, a low proportion of them said the flaggers are very visible or their directions are usually clear.

## Brightness of Arrow Boards

A majority of the surveyed drivers ( $76 \%$ ) said that arrow boards are too bright, while $22 \%$ said the brightness is okay, $1 \%$ said arrow boards are not bright enough, and $1 \%$ had no opinion. The responses to brightness of arrow boards were correlated to driving experience, miles driven in Illinois, age of drivers, carrier type, driving time, advanced signs, blowing dirt/dust, lane closure taper length, flaggers' visibility and directions given by them, usefulness of barricades and concrete barriers, height of arrow boards, brightness of CMB, confusing/unclear signs, and the need to add signs in Illinois work zones.

Drivers who said arrow boards are too bright had more driving experience than those who said the brightness is not enough. Drivers who mentioned that the brightness is okay drove more in Illinois than those who indicated that arrow boards are too bright. The truck drivers who said that arrow boards are too bright were older than those who indicated that brightness is okay.

Drivers who said the arrow boards are too bright were under-represented among the drivers who usually drove in daytime, liked to find out about work zones more than 5 miles ahead, did not feel uncomfortable due to lane closure taper length, or considered flaggers very visible. However, they were over-represented among drivers who wanted to find out about WZ in less than one mile, considered the height of arrow boards to be too high or too low, or said CMB are too bright.

On the other hand, a higher proportion of drivers who said the brightness is okay worked for private carriers, did not feel uncomfortable with blowing dirt or dust, said flaggers are very visible, or stated that the height of arrow board is okay. Nevertheless, a lower proportion of drivers said the flagger's directions were most of the times confusing, did not like the use of barricades or concrete barriers, said CMB are too bright, agreed that there are unclear or confusing signs, or wanted signs to be added to WZ.


## Driving Time

## Arrow Board

 Height

Add Signs









Over-Represented
Under-Represented

| Directions <br> by Flaggers |
| :---: |
| Barricade |
| Concrt Barrier |
| Barrel |
| Impct |
| Attenuator |



## Confusing Signs




Over-Represented
Under-Represented


## CHAPTER 8

## MULTIVARIATE ANALYSIS OF TRAVEL CHARACTERISTICS

In multivariate analysis the responses for more than two questions are considered at the same time. In this chapter, the responses to three questions are simultaneously considered in the statistical analyses. Since a large number of combinations of three-questions at a time is possible, multivariate analyses were performed for only a few important variables.

These combinations are: a) flagger's visibility, flagger's directions, and unclear/confusing signs, b) height of arrow boards, brightness of arrow board, and unclear/confusing signs, c) height of CMB, brightness of CMB, and unclear/confusing signs. To do the multivariate analysis, each sub-group must have a minimum number of observations in it. To satisfy this requirement, the appropriate categories with small numbers of observations were combined. The new categories and the percentages of observations are shown in Table 8.1. Six $\chi^{2}$ test were run to determine whether or not there were under/over representation of a certain combination of responses. The results of the tests are given in Table 8.2. In two cases the expected numbers of observations in the cells were less than 5 , so the tests were not made. The discussions for the other 4 cases are given below.

## Flaggers

The bivariate analyses in Chapters 6 and 7 indicated that the responses to the flagger's visibility, the directions given by them, and unclear or confusing signs were correlated. Drivers who said that flaggers are very visible were over-represented in those who said that the directions are usually clear. Drivers who said that flagger's visibility is okay were underrepresented, but drivers who said flaggers are hard to see were over-represented among those who answered that directions are confusing most of the times. Drivers who indicated that flaggers are very visible or their visibility is okay were under-represented, however drivers who replied that flaggers are hard to see were over-represented in those who indicated that there are unclear or confusing signs in the Illinois work zones. Drivers who said directions given by flaggers are usually clear were under-represented, but drivers who said that directions are most of the times confusing were over-represented in those who indicated that there are unclear or confusing signs in the Illinois work zones.

Drivers who said the flaggers are visible (very visible and visibility is okay combined) and the directions given by them are usually clear were under-represented among those who
indicated that unclear or confusing signs exist in Illinois WZ. However, drivers who said the flaggers are visible but the directions given by them are confusing (sometimes and most of the times combined) were over-represented among those who stated that unclear or confusing signs exist in Illinois WZ.

Also, drivers who said the flaggers are hard to see but the directions given by them are usually clear were under-represented among those who indicated that unclear or confusing signs exist in Illinois WZ. Furthermore, drivers who said the flaggers are hard to see and the directions given by them are confusing were over-represented among those who said unclear or confusing signs exist in Illinois WZ. These results from the multivariate analyses imply that the lack of clarity of the flagger's directions is a factor in saying that there are unclear or confusing signs in WZ. The implication is that the drivers associated the clarity of flagger's directions more than its visibility to the presence of unclear or confusing signs in WZ.

## Arrow Boards

The drivers responses on the height of arrow boards were correlated with what they think about their brightness. Drivers who thought arrow boards are too high or too low were overrepresented in those who indicated that arrow boards are too bright. Among drivers who considered the brightness of arrow boards okay, drivers who thought the height of arrow boards is okay were over-represented.

Drivers who said that arrow boards are either too high or too low were over-represented, but drivers who said arrow boards' height is okay were under-represented among those who indicated that there are unclear or confusing signs in the Illinois work zones. Drivers who said the brightness of arrow boards is okay were under-represented in those who indicated that there are unclear or confusing signs in the Illinois work zones.

With slightly less confidence ( $88 \%$ ), drivers who said the height of arrow boards and the brightness of the arrow boards are okay were under-represented among those who indicated that unclear or confusing signs exist in Illinois WZ. However, drivers who said the height of arrow board is okay but it is too bright were over-represented among those who said unclear or confusing signs exist in Illinois WZ. Furthermore, drivers who said the height is not okay (too high or too low) but the brightness is okay were under-represented among those who said unclear or confusing signs exist in work zones. The implication is that the drivers associated the brightness of arrow boards more than its height with their claim of unclear or confusing signs in WZ.

## Changeable Message Boards

The opinions on the height of CMB signs were correlated with those about their brightness. Drivers who said that CMB are too low were over-represented, but drivers who indicated that the height is okay were under-represented in those who also said they are not bright enough.

The perception of brightness of changeable message signs was found correlated with the opinions on the existence of unclear or confusing signs in work zones. Drivers who indicated that CMB are too bright were over-represented, but drivers who said the brightness of changeable message signs is okay were under-represented in those who mentioned that there are confusing or unclear signs in the Illinois work zones.

Within the group of drivers who said the height of CMB is not okay (too high or too low), there was not a significant relationship between CMB brightness and presence of unclear or confusing signs. However, within the group of drivers who said the height is okay, drivers who indicated that the brightness is not okay (too bright or not bright enough) were overrepresented among those who said unclear and confusing signs exist in the WZ. This implies that when the height is perceived to be appropriate, the drivers associated the brightness with the presence of unclear or confusing signs in WZ.

Table 8.1 Categories for Multivariate Analysis

## Flaggers

| Visible (66.7\%) |  |  |  | Hard to see (33.3\%) |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Directions are clear (40.3\%) |  | Directions are confusing (26.4\%) |  | Directions are clear (9.2\%) |  | Directions are confusing (24.1\%) |  |
| No unclear or confusing signs (37.5\%) | Unclear or confusing signs (2.8\%) | No unclear or confusing signs (23.1\%) | Unclear or confusing signs (3.3\%) | No unclear or confusing signs (7.6\%) | Unclear or confusing signs (1.6\%) | No unclear or confusing signs <br> (17.3\%) | Unclear or confusing signs (6.8\%) |

Arrow Boards

| Height is too high or too low (21.4\%) |  |  |  | Height is okay (78.6\%) |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Brightness is too bright(19.3\%) |  | Brightness is okay(2.1\%) |  | Brightness is too bright(57.6\%) |  | Brightness is okay(21.0\%) |  |
| No unclear or confusing signs (14.2\%) | Unclear or confusing signs (5.1\%) | No unclear or confusing signs (2.0\%) | Unclear or confusing signs (0.1\%) | No unclear or confusing signs (50.1\%) | Unclear or confusing signs (7.5\%) | No unclear or confusing signs (19.3\%) | Unclear or confusing signs (1.7\%) |

Changeable Message Boards

| Height is too high or too low (9.2\%) |  |  |  | Height is okay (90.8\%) |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Brightness is too bright (4.1\%) |  | Brightness is okay(5.1\%) |  | Brightness is too bright(20.5\%) |  | Brightness is okay(70.3\%) |  |
| No unclear or confusing signs (3.1\%) | Unclear or confusing signs (1.0\%) | No unclear or confusing signs (4.2\%) | Unclear or confusing signs (0.9\%) | No unclear or confusing signs (16.4\%) | Unclear or confusing signs (4.1\%) | No unclear or confusing signs (61.6\%) | Unclear or confusing signs (8.7\%) |

Table 8.2. Observed and Expected Number of Responses Used in Multivariate Analyses

| Unclear or <br> confusing <br> signs in work <br> zones | Flaggers are visible |  | Flaggers Are hard to see <br>  <br> Directions are <br> clear |  |
| :---: | :---: | :---: | :---: | :---: |
|  | Directions are <br> confusing | Directions are <br> clear | Directions are <br> confusing |  |
| 264 | 163 | 54 | .122 |  |
| Yes | $258)$ | $(169)$ | $(49)$ | $(127)$ |
|  | $(26)$ | 23 |  |  |
| $(17)$ | 11 | 48 |  |  |
|  | $\chi^{2}$-value $=3.832 ;$ Prob. $=0.050$ |  | $\chi^{2}$-value $=3.200 ;$ Prob. $=0.074$ |  |


| Unclear or <br> confusing <br> signs in work <br> zones | Height of arrow boards is <br> too high or too low |  | Height of arrow boards is okay |  |
| :---: | :---: | :---: | :---: | :---: |
|  | Arrow boards <br> are too bright | Brightness is <br> okay | Arrow boards <br> are too bright | Brightness is <br> okay |
| No | 100 <br> $(103)$ | 14 <br> $(11)$ | 354 <br> $(359)$ | 136 <br> $(131)$ |
| Yes | 36 <br> $(33)$ | 1 <br> $(4)$ | 53 <br> $(48)$ | 12 <br> $(17)$ |
|  | Not a valid test |  |  | $\chi^{2}$-value $=2.535 ;$ Prob. $=0.111$ |


| Unclear or <br> confusing <br> signs in work <br> zones | Height of CMBs is <br> too high or too low |  | Height of CMBs is okay |  |
| :---: | :---: | :---: | :---: | :---: |
|  | CMBs are too <br> bright | Brightness is <br> okay | CMBs are too <br> bright | Brightness is <br> okay |
| No | 10 <br> $(11)$ | 20 <br> $(19)$ | 116 <br> $(125)$ | 435 <br> $(426)$ |
| Yes | 3 <br> $(2)$ | 4 <br> $(5)$ | 29 <br> $(20)$ | 61 <br> $(70)$ |
|  | Not a valid test |  | $x^{2}$-value $=5.514 ;$ Prob. $=0.019$ |  |

Note: The value outside parenthesis is the observed and the one inside parenthesis is the expected number for that cell

## CHAPTER 9

## TRAVEL CHARACTERISTICS, ACCIDENTS, AND BAD DRIVING SITUATIONS

## ACCIDENT EXPERIENCES

This chapter discusses the relations between driver/travel characteristics and accident experiences as well as experiencing bad driving situation in work zones. First, the accident experience [20] and then the experience of bad driving situations in the WZ will be discussed. The term bad driving situations (BDS) is used because during pre-testing of the questionnaire we realized that truck drivers were using it to describe a difficult driving situation, a "near miss" accident situation, an unsafe driving situation, or situations with a higher risk of accidents.

Statistical analyses of accident experiences of the drivers are conducted for the entire work zone (overall) as well as for advance warning area (AWA), transition area (TRA), buffer space (BFS), work space (WKS), and termination area (TEA). Different statistical tests were used, based on the distribution characteristics of the responses for each question, as well as on the number of groups to be compared. For continuous variables the analysis of variance (ANOVA) was applied, and for the discrete variables, comparisons were made using $\chi^{2}$ goodness-of-fit tests. All statistical tests were performed, unless otherwise stated, with a $90 \%$ confidence level.

Locations of the accidents in work zones are not accurately coded in the accident files. Thus, an in-depth work zone accident study has not been possible. This study attempted to find the location of accidents by tapping on the experience of truck drivers. They were given a sketch of the work zone and were asked to identify the locations they experienced accidents. The sketch was divided into five parts - AWA, TRA, BFS, WKS, and TEA. They were also asked to indicate how many times they had experienced accidents. Thus, the number of drivers who experienced accidents and the number of accidents were determined for each part of work zones.

## Overall Experience of Accidents in Work Zones

A relatively small percentage of all truck drivers (6.1\%) said that they had accidents in one or two locations in work zones. About $1 \%$ have experienced accidents in two locations, and all of them included either the AWA or the TRA. The accidents were distributed among the five areas, but mainly were in AWA ( $2 \%$ ) and TRA ( $3 \%$ ). In the buffer space $0.5 \%$, in work space $1 \%$, and in termination area $0.6 \%$ of the respondents had accidents. These numbers may seem small, but actually are not. For instance, five out of every 100 drivers surveyed had accident(s) on the AWA and/or TRA. This is more than twice the number of accidents in the remaining
areas of the work zones. Accident experiences support the bad driving experience of the respondents.

A total of fifty one drivers said they had one or more accidents in work zones. Although some drivers indicated that they had accidents in more than one area in a work zone, no driver had more than one accident in the same area of the work zone. Table 9.1 (given at the end of this chapter) shows the frequency of accidents at different areas within a work zone. Those 51 drivers had experienced 59 accidents in work zones. About $42 \%$ of the accidents happened in the TRA and $29 \%$ happened in the AWA (see Figure 9.1 and Table 9.1 ). About $14 \%$ happened in the WKS, $8 \%$ in the TEA, and only $7 \%$ in the BFS. Comments and suggestions of truck drivers revealed that most of the accidents happened between passenger vehicles and trucks mainly due to lane changes and rapid speed reductions. Considering the number of truck drivers

Figure 9.1 Frequency of Accidents and Bad Driving Situations in Various Locations within Work Zones (\% of total number of accidents or BDS)


Notes: AWA(advanced warning area), TRA(transition area) BFS(buffer space), WKS(work space), TEA(termination area)
who had accidents and the location of accidents in work zones, safety improvements for truck driver should mainly focus on the TRA and the AWA.

## Categories of Analyses

To examine the correlations between the experience of bad driving situations (BDS) and/or accidents in work zones and other truck/drivers characteristics, statistical analyses were conducted in the following four categories.

1. Correlation of accidents with travel characteristics.
2. Correlation between accident experience and BDS.
3. Correlation of BDS with travel characteristics.
4. Correlation of BDS in each work zone areas with travel characteristics.

## Correlation of Accidents with Travel Characteristics

A small portion of drivers ( $6.1 \%$ ) indicated that they had one or more accidents in the work zones. For the purpose of the statistical analyses, drivers were grouped into two categoriesthose who experienced accidents at any point in the work zones, and those who did not. Possible correlations between driver and/or vehicle characteristics and experience of accident were examined.

ANOVA shows that none of the driving experience, age, and miles driven were related to the accident experience. The summary of $\chi^{2}$ goodness-of-fit tests is given in Table 9.2. Detailed accident analysis for each area in the work zones was not possible because of the small number of drivers who had accidents. The $\chi^{2}$ tests show that accident experience were significantly related to the experience of bad driving situations, but not other driver/truck characteristics. Some trends were also emerged indicating relation, though not statistically significant, between accident experience and advance sign, speed limit of 55 mph , and unclear/confusing signs. These trends can be characterized as follows: in a group of drivers who had accidents in work zones, those who wanted to know about work zones 3 kilometers ( 2 miles) or less in advance were over-represented and 5-8 kilometers ( $3-5$ miles) in advance were underrepresented, those who mentioned unclear or confusing signs in work zones were overrepresented, and those who feel the speed limit of 55 mph in work zones is too fast were underrepresented and strangely those who said it is about right were over-represented.

It should be noted that, Table 9.2 indicates that the drivers accident experiences were not related to most of the other responses. It would be an over-simplification if one concludes from Table 9.2 that accidents happen regardless of characteristics of drivers, vehicles, and/or geometric of work zones. This over-simplification would not be an accurate statement. Stoke and Simpson [21] found that new drivers are more likely to be involved in truck crashes than experienced drivers.

Some relationships between travel characteristics and accidents in work zones revealed
interesting results, although the results of $\chi^{2}$ test did not indicate these to be statistically significant with confidence level of $90 \%$. It was noticed that more than the expected number of truck drivers who had accidents in work zone said, they drive double-bottom trucks, they want to find out about work zones far ahead (e.g., 10-16 kilometers ( $6-10$ miles)), they drive more than 50 mph in work zones with a 45 mph speed limit, they think the CMB are too bright, and they think some signs are unclear/confusing in work zones. On the other hand, more than the expected truck drivers who had not had any accidents in the work zones said, they think the speed limit of 55 mph in work zones is too fast, they drive less than 50 mph in work zones with a 45 mph speed limit, they think the visibility of flaggers is okay, but the directions by flaggers are confusing.

In addition to this interpretation, the following may also be interesting findings: type of carrier, time of driving, type of permit, assessment of hazard, preference of a certain type of work zone, height and brightness of arrow boards, and height of CMB were not related to accidents in work zones.

## Correlation Between Accident Experience and Bad Situations

There was a very strong correlation between the experience of bad situations and accidents in work zones (Tables 9.2 and 9.3). To further examine this relationship drivers were grouped into two categories- those who had BDS in work zones and those who did not. Then, the drivers in one category were further divided into two sub-categories - those who had accidents and those who did not. The numbers of observations in each category are given in Table 9.4. A higher than expected proportion of drivers who experienced BDS had also accidents in work zones. Conversely, among the drivers who had accidents in work zones, those with the experience of BDS were over-represented.

The synopsis of the relationships between accidents and BDS experiences at different areas of work zones are as follows. Those who have had accidents in work zones also had experienced more bad situations in work zones. Those drivers who had experienced BDS in AWA and TRA also showed a correlation with accident experience. Accident experience at WKS was also related to BDS experience and was significant at $89 \%$ confidence level. However, buffer space and termination areas did not show a significant relationship between accident and bad driving experience.

## BAD DRIVING SITUATIONS

This study attempted to find the location of accidents and BDS by tapping on the experience of truck drivers. They were given a sketch of a work zone and asked to identify the locations they
experienced BDS.
The sketch was divided into five parts - advance warning area (AWA), transition area (TRA), buffer space (BFS), work space (WKS), and termination area (TEA). Drivers were asked to indicate on the sketch where they had experienced BDS. They were also asked to indicate how many times they had experienced the difficulty and/or the accident. The number of drivers who experienced BDS and/or had accidents were determined for each part of the WZ.

## Overall Experience of Bad Driving Situations in the Work Zone

Two thirds of the surveyed drivers ( $66 \%$ ) said that they had experienced BDS in one or more areas of the WZ. About $29 \%$ of the respondents had experienced BDS in more than one location. The proportion of surveyed drivers with BDS were computed for different parts of the WZ, see Figure 9.1. The TRA was the one with the highest proportion ( $43 \%$ ) followed by AWA ( $24 \%$ ), WKS ( $13 \%$ ), TEA ( $11 \%$ ), and BFS ( $9 \%$ ). About $59 \%$ of the surveyed drivers indicated that they had experienced BDS in AWA and/or TRA. This is a very high number and indicates that efforts for improving driving situations in the WZ should concentrate more in these two areas. The drivers complained that cars merge too late or try to pass the trucks right before the narrow section of the highway.

## Correlations of Bad Driving Situations with Travel Characteristics

Some drivers indicated that they had experienced one or more BDS in WZ. For the purpose of the statistical analyses, drivers were grouped into two categories - those who experienced BDS at any point in the WZ, and those who did not. We attempted to see whether there was any correlation between driver/vehicle characteristics and experience of BDS. Table 9.3 provides a summary of the results for the $\chi^{2}$ tests.

Drivers who experienced BDS, were slightly younger ( 42.6 vs. 43.5 years), had slightly less driving experience ( 15.9 vs. 16.7 years), and drove fewer miles ( 111,000 vs. 115,000 ) compared to those who did not have BDS experience. Although mean values of these characteristics among drivers who experienced BDS in WZ are slightly smaller than mean values for those who did not, the differences were not statistically significant at the confidence level of $90 \%$.

Truck types and carriers types were significant factors in experiencing BDS in WZ. As an example, the $\chi^{2}$ test shows that double-bottom truck drivers were over-represented in experiencing BDS in WZ, while chemical/tanker drivers were under-represented. Common carrier drivers were over-represented in experiencing BDS in WZ. A high mix of drivers and truck types in the common carrier might be one of the causes for the relation between the carrier
type and the experience of bad situations in WZ.
The correlation between carrying a permit and the experience of BDS in WZ was not significant with $90 \%$ confidence level, but it was significant at a slightly lower confidence level ( $86 \%$ ). This indicates that drivers carrying hazardous materials were over-represented among those who experienced BDS in WZ.

Experiencing BDS in WZ was also statistically related to the perception of hazard in work zones. Those who considered driving in WZ to have the same hazard level as non-work zones were under-represented, and those who perceived WZ to be more hazardous were overrepresented in experiencing BDS in WZ. This finding is in a way the reflection of drivers experience in WZ.

Experiencing BDS in WZ and having accidents in WZ are highly correlated with each other. A higher than expected percentage of drivers who have had accidents in $W Z$ said that they also have experienced BDS in WZ.

Several factors such as speed, flagger, and drivers preference of WZ configuration were not related to the frequency of having bad driving experience. Also, neither the desired distance for advance WZ signs nor the preference of WZ configuration were related to the experience of BDS in WZ. Thus, those who preferred crossover, one lane closure, or had no preference had similar BDS experiences.

Similarly, perception of 55 mph speed limit in work zones and the actual speed in work zones with a 45 mph speed limit were also not related to the experience of bad situations in work zones. However, those who perceive 55 mph speed limit is too slow were over-represented among those who experienced BDS in WZ at a lower confidence level ( $81 \%$ ).

The visibility of flaggers and the directions given by flaggers were not factors in experiencing BDS in WZ. However, $\chi^{2}$ tests showed that the brightness of arrow boards was a factor in the BDS experience. Those who said arrow boards are too bright were overrepresented among drivers who faced BDS. With a slightly lower than $90 \%$ confidence level, similar statements can be made for the height of arrow board. For changeable message boards (CMB), the height was related to the experience of BDS, but not the brightness. Those who said the height of CMB are too low were over-represented in those who had BDS experience.

The experience of BDS in WZ was not related to whether there was unclear/confusing signs in the work zones. Those with BDS were over-represented among drivers who indicated that more signs should be added to the work zones.

## Correlation of BDS in Each Area with Travel Characteristics

After identifying the relationship between the experience of BDS in the "overall" work zone and travel characteristics, more specific analyses were performed to find out the relationships
between the experience of BDS in different parts of the WZ and travel characteristics.
Five sets of statistical analyses were performed, one for each part of the WZ. For each set of the statistical analyses, the drivers were grouped into two categories - those who had a BDS experience at that part of the WZ only and those who did not. The ANOVA and $\chi^{2}$ test were performed for each part separately. Tables 9.5 and 9.6 provide summaries of ANOVA and $\chi^{2}$ tests for the relationships between BDS experience in a specific location and the travel characteristics. When the differences among driver groups are statistically significant at the confidence level of $90 \%$, the detailed discussions are given in the following section.

## Advance Warning Area (AWA)

The experience of BDS in advanced warning areas was correlated with the responses to the type of permits carried by drivers, advance signing of work zones, accident experiences in work zones, opinions about arrow boards height, and the need for additional signs. Drivers who have experienced BDS in advanced warning areas were over-represented in those who were carrying a permit for hazardous materials, those who want to know about a work zone less than 1 mile ahead, those who have had accidents in work zones, those who said that arrow boards are too high, or those who need additional signs in the Illinois work zones. However, they were under-represented among those who wanted to know about the work zones 1-2 miles ahead.

There were also relationships between BDS experience in AWA and type of carrier, speed limit of 55 , brightness of arrow board, and brightness of CMB . These relationship were not statistically significant at $90 \%$ confidence level, but were close enough to the cut off point to indicate certain trends.

## Transition Area (TRA)

The experience of BDS in the transition area was correlated with responses to age, experience, carrier type, perceived hazard of traveling in work zones, six work zone features (merging to an open lane, median crossovers, lack of shoulders, pavement edge dropoff, lane width, and lane closure taper length), the opinion on the 55 mph speed limit in work zones, travel speed on a WZ with 45 mph speed limit, accident experience in WZ, flagger's visibility, the helpfulness of barricades and white plastic barricades, and brightness of CMB (see Table 9.6 and Appendix D for Chi-Square test results for Q. 12 and 13 vs all others).

The driving experience and age were significant factors in facing BDS in TRA. The drivers who were younger or had less driving experience were over-represented among those drivers who had BDS in TRA. Drivers from private carriers were under-represented among those who have experienced BDS in TRA. Experiencing BDS in TRA was found to be
correlated with how the drivers assess the hazard of traveling in WZ compared to non-work zones. Drivers who responded that driving through WZ have the same hazard level as non-WZ were under-represented among those who have experienced bad situations in TRA.

Drivers who have experienced BDS in transition areas were over-represented in those who said that the above six work zone feature make them feel uncomfortable, or those who do not like the use of barricades or white plastic barricades in work zones.

The experience of BDS in TRA was correlated to how drivers perceive the speed limit of 55 mph and how fast they travel through a WZ with 45 mph speed limit. Drivers who think that the 55 mph speed limit is too slow were over-represented among those who experienced BDS in TRA. Similarly, drivers who travel at speeds above 55 mph in 45 mph speed limit zones were over-represented in that group. On the other hand, drivers who said that the 55 mph limit is about right, as well as those who travel below 45 mph in WZ of 45 mph limit, were under-represented in that group.

Similar to AWA, drivers who have had accidents in work zones were over-represented in those who have experienced BDS in TRA.

Drivers who indicated the flaggers are visible were under-represented in those who have experienced BDS in TRA. Similarly, drivers who said the brightness of the arrow board is okay were also under-represented in them. Type of work zones and directions given by flaggers show certain trends at slightly less confidence levels ( $83 \%$ and $86 \%$, respectively).

## Buffer Space (BFS)

The experience of BDS in the buffer space was correlated with the responses to truck type, the preference of work zone types, three work zone features (median crossovers, lack of shoulders, and lane width), flagger's visibility, the usefulness of concrete barriers, and the presence of unclear or confusing signs. Drivers who have experienced BDS in the buffer space were over-represented in those who drive flatbed or lowboy trucks, those who prefer one-lane closure, those who feel uncomfortable in median crossovers, lack of shoulders or lane width, those who said flaggers are hard to see, those who indicated that there are unclear or confusing signs, or those who wanted additional signs in the work zones. However, they were underrepresented in those who drive tanker/chemical or special purpose trucks, those who do not have any preferences in work zone layout, or those who think concrete barriers as helpful.

There are trends between the directions given by flaggers and brightness of CMB with experience of BDS in BFS. At $87 \%$ confidence level, drivers who said that the directions given by flaggers were confusing most of the time were over-represented in the experience of BDS in BFS. Also, at $88 \%$ confidence level, drivers who said changeable message board is not bright enough were over-represented in those who have experienced bad situations in BFS.

The experience of BDS in the work space was correlated with the responses to vehicle miles traveled (VMT), the carrier type, advanced signs about WZ, three work zone features (merging to an open lane, median crossovers, and lack of shoulders), the 45 mph speed limit zone, and the helpfulness of cones. Drivers with lower VMT ( 104,000 vs. 114,000 ) were over-represented among those drivers with BDS experiences in WKS.

Drivers who have experienced BDS in the work space were over-represented in those who drive trucks for common carriers, those who want to know about work zones 2 miles or less, those who said that merging to an open lane, median crossovers or lack of shoulders make them feel uncomfortable, in those who travel below 45 mph or at $51-55 \mathrm{mph}$ in work zones of 45 mph speed limit, or those who do not like the use of cones. However, they were underrepresented in those who were driving trucks for private carriers, or those who drive $46-50 \mathrm{mph}$ in $45-\mathrm{mph}$ speed limit areas.

Thus, those who were traveling too fast or too slow were over-represented in those who have experienced BDS in WKS. This seems to indicate that those who deviated from the "group" speed end up experiencing BDS in WKS more often. Also there are strong trends between the BDS experience and accidents.

## Termination Area

The experience of BDS in termination areas was correlated with the responses to four work zone features (to merging to an open lane, median crossovers, lack of shoulders, and lane-closure taper length), flagger's visibility, flagger's directions, height of arrow boards, the presence of unclear or confusing signs, and the need for additional signs in WZ. Drivers who have experienced BDS in termination areas were over-represented in those who said that merging to an open lane, median crossovers, lack of shoulders or lane-closure taper length make them feel uncomfortable, those who said that flaggers are hard to see or the directions given by flaggers are confusing, those who said arrow boards are too high, those who indicated the presence of unclear or confusing signs in the Illinois work zones, or those who said signs should be added to work zones. However, they were under-represented in those who said that flaggers are very visible or the directions given are usually clear.

There was a trend, although not statistically significant at $90 \%$ confidence level, between the BDS experience in TEA and type of trucks. The trend seems to indicate that double bottom trucks were under-represented in those who have experienced BDS in TEA while those of tanker/hopper and chemical were over-represented.

TABLE 9.1 The frequency the drivers indicated they had accidents in work zones

| Had Accident | No of <br> Drivers | No of Accidents in Different Locations <br> in Work Zones |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | AWA | TRA | BFS | WKS | TEA |  |
| Only in one area |  | 13 | 19 | 2 | 4 | 5 |  |
| In AWA and TRA |  | 2 | 2 | - | - | - |  |
| In AWA and BFS |  | 1 | - | 1 | - | - |  |
| In AWA and WKS |  | 1 | - | - | 1 | - |  |
| In TRA and BFS | 1 | - | 1 | 1 | - | - |  |
| In TRA and WKS | 3 | - | 3 | - | 3 | - |  |
| Total no of drivers <br> involved | 51 | 17 | 25 | 4 | 8 | 5 |  |
| Total number of <br> accidents | - |  |  | 59 |  |  |  |
| Percent of <br> accidents in each <br> area | - | 28.8 | 42.4 | 6.8 | 13.6 | 8.5 |  |

Note:
AWA (advance warning area), TRA (transition area), BFS (buffer space), WKS (work space), TEA (termination area)

Table 9.2. Results of $\chi^{2}$ tests: accidents in work zones versus travel characteristics

| Items | D.F | $\begin{gathered} \chi^{2}- \\ \text { value } \end{gathered}$ | Prob. for $\geq \chi^{2}$ Value | Interpretation (90\% Confidence) |
| :---: | :---: | :---: | :---: | :---: |
| type of truck | 4 | 2.395 | 0.664 | Not significant |
| type of carrier | 2 | 0.904 | 0.636 | Not significant |
| time of driving | 1 | 0.689 | 0.406 | Not significant |
| type of permit | 2 | 0.343 | 0.843 | Not significant |
| location of advance sign | 3 | 5.286 | 0.152 | *Not significant |
| hazard of work zones | 1 | 0.414 | 0.520 | Not significant |
| type of work zones | 2 | 0.118 | 0.943 | Not significant |
| speed limit of 55 mph | 2 | 3.359 | 0.186 | Not significant |
| speed of 45 mph zone | 4 | 3.207 | 0.524 | Not Significant |
| bad driving experience | 1 | 13.097 | 0.000 | Significant |
| visibility of flagger | 2 | 2.875 | 0.237 | Not significant |
| directions by flagger | 2 | 2.134 | 0.344 | Not significant |
| height of arrow board | 2 | 0.703 | 0.703 | Not significant |
| brightness of arrow board | 1 | 0.000 | 1.000 | Not significant |
| height of CMB | 1 | 0.011 | 0.917 | Not significant |
| brightness of CMB | 2 | 3.049 | 0.218 | Not significant |
| unclear/confusing sign | 1 | 2.559 | 0.110 | *Not significant |
| addition of sign/message | 1 | 0.512 | 0.474 | Not significant |

Notes:

- When $\chi^{2}$ tests were not valid because of the low expected frequencies of cells, grouping of each question was performed.
- When the degree of freedom is 1 , continuity-adjusted $\chi^{2}$ values were used.
* May indicate a strong trend although it is not significant.

TABLE 9.3. Results of $\chi^{2}$ tests: experience of BDS in WZ versus travel characteristics

| Items | D.F. | $\chi^{2}$-value | Prob. for <br> $\geq \chi^{2}$ Value | Interpretation <br> (90\% Confidence) |
| :---: | :---: | :---: | :---: | :---: |
| type of truck | 4 | 9.804 | 0.044 | Significant |
| type of carrier | 2 | 11.232 | 0.004 | Significant |
| time of driving | 1 | 2.402 | 0.121 | $*$ Not significant |
| type of permit | 2 | 3.994 | 0.136 | *Not significant |
| location of advance sign | 3 | 4.781 | 0.189 | Not significant |
| hazard of WZ | 1 | 4.512 | 0.034 | Significant |
| type of WZ | 2 | 2.484 | 0.289 | Not significant |
| speed limit of 55 mph | 2 | 3.406 | 0.182 | Not significant |
| speed of 45 mph zone | 4 | 3.999 | 0.406 | Not Significant |
| accidents in WZ | 1 | 14.224 | 0.000 | Significant |
| visibility of flagger | 2 | 2.284 | 0.319 | Not significant |
| directions by flagger | 2 | 3.369 | 0.186 | Not significant |
| height of arrow board | 2 | 4.507 | 0.105 | $*$ Not significant |
| brightness of arrow board | 1 | 3.224 | 0.073 | Significant |
| height of CMB | 1 | 2.977 | 0.084 | Significant |
| brightness of CMB | 2 | 1.232 | 0.540 | Not significant |
| unclear/confusing sign | 1 | 1.672 | 0.196 | Not significant |
| addition of sign/message | 1 | 7.942 | 0.005 | Significant |

Notes:

- When $\chi^{2}$ tests were not valid because of the low expected frequencies of cells, grouping of each question was performed.
- When the degree of freedom is 1 , continuity adjusted $\chi^{2}$ values were used.
* Indicates it is not statistically significant, but may indicate a trend.

TABLE 9.4. Frequency of accident and BDS experiences in WZ

|  | Had Accident Experiences |  |  |
| :---: | :---: | :---: | :---: |
| Had BDS <br> Experiences | Yes | No | Row <br> total |
| Yes | 46 <br> $(8.4 \%)$ | 504 <br> $91.6 \%$ | 550 <br> $(100 \%)$ |
| No | 5 <br> $(1.8 \%)$ | 279 <br> $(98.2 \%)$ | 284 <br> $(100 \%)$ |
| Column total | 51 <br> $(6.1 \%)$ | 783 <br> $(93.9 \%)$ | 834 <br> $(100 \%)$ |

TABLE 9.5. Summary of ANOVA tests for BDS experience in WZ for continuous travel characteristic variables

| Items | Prob. for $>F$ Value |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Overall | AWA | TRA | BFS | WKS | TEA |
| Driving Experience | 0.3230 | 0.6784 | 0.0681 | 0.7575 | 0.6368 | 0.1991 |
| Age | 0.2312 | 0.6407 | 0.0215 | 0.5578 | 0.4100 | 0.7883 |
| Miles Driven in <br> USA | 0.1286 | 0.3220 | 0.9255 | 0.6044 | 0.0187 | 0.3382 |

Note:
AWA (advance warning area), TRA (transition area), BFS (buffer space), WKS (work space), TEA (termination area)

TABLE 9.6. Results of Chi-square Goodness-of-fit tests: experience of BDS in a specific location versus travel characteristics

| Items | Prob. for $\geq \chi^{2}$ Value |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Overall | AWA | TRA | BFS | WKS | TEA |
| type of truck | 0.044 | 0.171 | 0.875 | 0.061 | 0.862 | 0.186 |
| type of carrier | 0.004 | 0.110 | 0.061 | 0.407 | 0.020 | 0.766 |
| time of driving | 0.121 | 0.175 | 0.345 | 0.261 | 0.375 | 0.897 |
| type of permit | 0.136 | 0.034 | 0.237 | 0.240 | 0.578 | 0.443 |
| location of advance sign | 0.189 | 0.042 | 0.918 | 0.626 | 0.062 | 0.700 |
| hazard of WZ | 0.034 | 0.596 | 0.004 | 0.835 | 0.567 | 0.592 |
| type of WZ | 0.289 | 0.627 | 0.165 | 0.005 | 0.674 | 0.166 |
| speed limit of 55 mph | 0.182 | 0.104 | 0.003 | 0.782 | 0.559 | 0.327 |
| speed of 45 mph zone | 0.406 | 0.230 | 0.044 | 0.420 | 0.043 | 0.780 |
| accidents in WZ | 0.000 | 0.030 | 0.078 | 0.335 | 0.110 | 0.863 |
| visibility of flagger | 0.319 | 0.426 | 0.067 | 0.053 | 0.327 | 0.010 |
| directions by flagger | 0.186 | 0.822 | 0.135 | 0.123 | 0.206 | 0.007 |
| height of arrow board | 0.105 | 0.018 | 0.266 | 0.837 | 0.101 | 0.084 |
| brightness of arrow board | 0.073 | 0.115 | 0.067 | 1.000 | 0.252 | 0.316 |
| height of CMB | 0.084 | 0.572 | 1.000 | - | 0.315 | - |
| brightness of CMB | 0.540 | 0.114 | 0.672 | 0.115 | 0.645 | 0.337 |
| unclear/confusing sign | 0.196 | 1.000 | 0.208 | 0.038 | 0.415 | 0.002 |
| addition of sign/message | 0.005 | 0.002 | 0.358 | 0.095 | 0.164 | 0.023 |

Notes:

- AWA (advance warning area), TRA (transition area), BFS (buffer space), WKS (work space), TEA (termination area)
- Empty cells show that cell frequency was not enough for Chi-square test.


## CHAPTER 10

## ILLINOIS DRIVERS' COMPARED TO NON-ILLINOIS DRIVERS

There is a great deal of uniformity in signing and layout of work zones in the US. All states use the MUTCD as the basis for their traffic control plan. However, beyond meeting the minimum requirements of MUTCD [22], there are some differences from states to states. For example, Illinois uses two arrow boards in interstate work zones, but some states (e.g. Indiana) use only one arrow board.

It would be interesting to compare the differences in the opinions of "Illinois drivers" and "non-Illinois drivers." The two categories of drivers were identified based on the annual miles driven in Illinois and US. The following ratio was calculated:

$$
\text { Ratio }=\frac{\text { Annual Miles Driven in Illinois }}{\text { Annual Miles Driven in U.S. }}
$$

If a driver traveled mainly on non-Illinois highways, then the ratio should be closer to 0 . Conversely, if he/she mainly traveled on Illinois highways, then the ratio should be closer to 1. If he/she traveled equally in Illinois and non-Illinois highways, then the ratio should be close to 0.5 .

Based on the annual miles traveled in Illinois and U.S. and the ratio, two groups of drivers were selected from the sample: "llinois drivers" whose annual miles driven in Illinois is greater than or equal to 20,000 miles and the ratio is greater than or equal to 0.4 , and "NonIllinois drivers" whose annual miles driven in Illinois is smaller than or equal to 10,000 miles and the ratio is less than or equal to 0.1 .

Then drivers who traveled extremely small or extremely large number of miles were deleted from the groups (such as drivers who drove less than 20,000 miles or more than 200,000 miles annually in U.S., and drivers who drove 0 mile or more than 100,000 miles annually in Illinois ). Through this process, the numbers of "Illinois drivers" and "non-Illinois drivers" were found to be 119 ( $14.3 \%$ ) and $180(21.6 \%)$, respectively.

In order to find out the differences in the opinions between "Illinois drivers" and "nonIllinois drivers," two statistical tests were used: analysis of variance (ANOVA) for continuous items and $\chi^{2}$ goodness-of-fit tests for categorical items (see Tables 10.1 and 10.2). A $90 \%$ confidence level was used in both tests.

## Comparisons of Drivers Characteristics

The results in this section are based on ANOVA tests conducted to compare the responses from Illinois drivers to those from the non-Illinois group. When there were statistically significant differences in the responses from Illinois and non-Illinois groups, explanations are given.

1: Average driving experiences were statistically different in two groups. "Illinois drivers" (15.8 year) had less driving experience than "non-Illinois drivers" (19.0 years).

2a: Average annual miles driven in U.S. were statistically different in two groups. "Illinois drivers" ( 96,000 miles) traveled less miles in U.S than "non-Illinois drivers" (113,000 miles).
2b: Average annual miles driven in Illinois were also statistically different in two groups. "Illinois drivers" ( 60,000 miles) travelled more miles in Illinois than "non-lllinois drivers" ( 6,000 miles)
3: Average ages were not statistically different in two groups at a $90 \%$ confidence level ( 42.6 vs. 44.5 years), although there was a trend.

## Comparisons of Drivers' Opinions

The results in this section are based on $\chi^{2}$ goodness-of-fit tests. The tests are conducted to compare the responses from Illinois and non-Illinois drivers. When the responses were statistically different, the results are discussed. Please note that, the following sentences are equivalent in the meaning: "Illinois drivers" were over-represented (under-represented) in those..., and "Non-Illinois drivers" were under-represented (over-represented) in those...

4a: "Illinois drivers" were under-represented in those who drove box van trucks, but were over-represented in those who drove double bottom, tanker/hopper, chemical, or special purpose trucks.
4b: "Illinois drivers" were under-represented in those who drove trucks for common carriers, but were over-represented in those who drove trucks for private carriers.
5: "Illinois drivers" were over-represented in those who drove trucks usually in daytime.
10C: "Illinois drivers" were under-represented in those who said that the lack of shoulders did not make them uncomfortable when driving through work zones.
10I: "Illinois drivers" were under-represented in those who said that lane closure taper length did not make them uncomfortable when driving through work zones.
11A: "Illinois drivers" were over-represented in those who thought that 55 mph speed limit in
work zones is too fast.
11B: "Illinois drivers" were over-represented in those who usually drove below 45 mph in work zones, but were under-represented in those drove $46-50 \mathrm{mph}$ in work zones with 45 mph speed limit.
13: "Illinois drivers" were over-represented in those who had accident(s) in work zones.
15D: "Illinois drivers" were under-represented in those who did not like concrete barriers in work zones.

16B: "Illinois drivers" were under-represented in those who said that arrow boards in work zones are too bright, but were over-represented in those who said that their brightness is okay.
17B: "Illinois drivers" were over-represented in those who said that CMBs in work zones are too bright, but were under-represented in those who said that their brightness is okay.

Table 10.1 Results of ANOVA based on "Illinois drivers" and "non-Illinois drivers"

| Item | "Illinois <br> Drivers" | "Non-Illinois <br> Drivers" | p-value | Interpretation <br> at $\alpha=0.1$ |
| :---: | :---: | :---: | :---: | :---: |
| Driving <br> Experience | 15.8 years | 19.0 years | 0.0071 | Significant |
| Miles driven <br> in U.S. | 96,000 miles <br> per year | 113,000 miles <br> per year | 0.0001 | Significant |
| Miles Driven <br> in Illinois | 60,000 miles <br> per year | 6,000 miles <br> per year | 0.0001 | Significant |
| Age | 42.6 years | 44.5 years | 0.1136 | Not Significant |

Table 10.2 Results of $\chi^{2}$ goodness-of-fit tests based on "Illinois drivers" and "non-Illinois drivers"

| Question No. | p-value | Question No. | p -value |
| :---: | :---: | :---: | :---: |
| 4 a | .000 | 12 | .687 |
| 4 b | .050 | 13 | .017 |
| 5 | .005 | 14 a | .326 |
| 6 | .748 | 14 b | .836 |
| 7 | .302 | 15 A | .435 |
| 8 | .706 | 15 B | .773 |
| 9 | .245 | 15 C | .840 |
| 10 A | .222 | 15 D | .044 |
| 10 B | .860 | 15 E | .555 |
| 10 C | .036 | 15 F | .216 |
| 10 D | .136 | 15 G | .271 |
| 10 E | .905 | 16 a | .366 |
| 10 F | .468 | 16 b | .000 |
| 10 G | .991 | 17 a | .413 |
| 10 H | .231 | 17 b | .036 |
| 10 I | .060 | 18 | .650 |
| 11 a | .086 | 19 | .167 |
| 11 b | .036 | 20 | 1.000 |

## SUMMARY AND CONCLUSIONS

The findings of this study are based on the opinion survey of 834 semi-trailer truck drivers. The drivers indicated that they are aware of the hazard of traveling through work zones, and $90 \%$ of them consider it to be more hazardous than driving in non-work zone areas. However, a previous study $[18,19]$ found that only $54 \%$ of all drivers (mostly car drivers) considered traveling through work zones to be more hazardous. Truck drivers want to know far ahead about work zones and about half of them want to see a sign 3-5 miles ahead. The less experienced drivers want, in general, to find out about WZ far in advance than more experienced drivers. The age and driving experience were correlated to the type of truck driven.

Truck drivers do not have a clear preferred work zone configuration. About $36 \%$ preferred the median crossover, $33 \%$ preferred the one-lane closure layout, and $29 \%$ said that they have no preference. Drivers who indicated that work zones are more hazardous than nonwork zones were over-represented among drivers who prefer the one-lane closure.

The assessments of work zone features and hazard of traveling in WZ were correlated with truck driving experience. The average age and experience were higher for drivers who said the flaggers are hard to see, arrow boards are too bright, and confusing and unclear signs exist in WZ. Arrow boards seem to be too bright for a majority of truck drivers. About $3 / 4$ of the drivers indicated that the arrow board was too bright, but the height was okay.

Most of the truck drivers ( $86 \%$ ) said there were not confusing and/or unclear signs in work zones, but $14 \%$ disagreed. Comments about confusing and/or unclear signs were directed toward the signs for lane closure, CMB, speed limit, exit ramp, and work zones without actual work. Similarly, about $78 \%$ said that there is no need to add signs or messages to work zones, however, $22 \%$ said some signs should be added. Drivers suggested adding signs about early merging, early notification of work zones, road conditions, construction length, and speed limits. Truck drivers suggested adding signs to indicate specifically when to merge in order to prevent the last minute merging by some car drivers.

Work zone features such as merging to an open lane, median crossovers, lack of shoulders, pavement edge dropoff, loose construction materials on open lane, blowing dirt or dust, lane width, driving in " S " curves, and lane closure taper length made at least half of the drivers feel uncomfortable either sometime or most of the times. Particularly, pavement edge dropoff, loose construction materials, lack of shoulders, and lane width made over $85 \%$ of the drivers uncomfortable either sometimes or most of the times.

The assessment of an appropriate work zone speed limit and the travel speed in a work zone with a $45-\mathrm{mph}$ speed limit were correlated. Travel speeds seem to be a function of truckers' age or experience- the lower the age or experience the higher the travel speed. About $2 / 3$ of them think the speed limit of 55 mph is about right, but $1 / 4$ think it is too fast. Nearly
half of them would exceed a speed limit of 45 mph , and over $1 / 6$ of them would exceed the speed limit by more than 5 mph . Drivers who said that the 55 mph speed limit is too slow were over-represented among those who travel over 45 mph in a work zone with a 45 mph speed limit, and the opposite was true for those who said the 55 mph speed limit is too fast.

Some drivers have difficulty in seeing flaggers and/or understanding the directions given by them. About $1 / 3$ said the flaggers are hard to see and about $1 / 2$ said that directions given by flaggers were confusing sometimes or most of the time. Drivers who said that flaggers are very visible were over-represented in a group who said that the directions are very clear. However, drivers who said the flaggers are hard to see were over-represented among those who said the directions given are confusing most of the time. Drivers who indicated flaggers are hard to see were over-represented in those who mentioned the presence of unclear or confusing signs as well as those who indicated the need for more signs in the Illinois work zones.

The results from multivariate analyses indicated that the lack of clarity of the flagger's directions was a factor in saying that there are unclear or confusing signs in WZ. Thus, the drivers associated the clarity of flagger's directions more than its visibility to the presence of unclear or confusing signs in WZ. Also, the drivers associated the brightness of arrow boards more than its height with their claim of unclear or confusing signs in WZ. Furthermore, when the height of CMB was perceived appropriate, the drivers associated the brightness of CMB with the presence of unclear or confusing signs in WZ.

Among the traffic control devices, impact attenuators were ranked the highest in terms of helpfulness. About $85 \%$ said impact attenuators are very helpful or somewhat helpful. For concrete barriers, $70 \%$ said they are very helpful or somewhat helpful. Approximately $79 \%$ to $84 \%$ of drivers considered the cones, white plastic barricades, and barrels very helpful or somewhat helpful. For barricades $76 \%$ and for tubes $75 \%$ of drivers said they are very helpful or somewhat helpful.

A small percentage of truck drivers (6\%) had accidents in the work zones, but approximately $66 \%$ of the drivers said that they had experienced bad driving situations (BDS) in one or more location, and $29 \%$ had experienced BDS in more than one location in work zones. The transition area had the highest proportion of BDS ( $45 \%$ ), followed by the advanced warning area ( $25 \%$ ), the work space ( $14 \%$ ), the termination area ( $11 \%$ ), and the buffer space $(10 \%)$. The distribution of the number of accidents were as follow: $42 \%$ of them happened in the transition area, $29 \%$ in the advanced warning area, $14 \%$ in the work space, $9 \%$ in the termination area, and $7 \%$ in the buffer space. Accident experience was correlated to the experience of bad driving situations, but not other driver/truck characteristics. A higher than expected proportion of drivers who experienced BDS also had accidents in the work zones. The BDS experience is a good indicator of the problem areas in work zones.

The perception of hazard in WZ was related to the experience BDS in WZ. Those who
perceived WZ to be more hazardous, the height of CMB was too high, or wanted more signs to be added to work zones were over-represented among those who experienced BDS in the WZ. Considering overall experience of BDS in work zones, common carrier drivers and doublebottom truck drivers were over-represented, while chemical/tanker drivers were underrepresented. With slightly less confidence, data indicated that a higher proportion of drivers carrying hazardous materials, as well as drivers who perceived 55 mph speed limit is too slow have experienced BDS in WZ.

Among the drivers who have experienced BDS in AWA, those who were carrying permits for hazardous materials, had accidents, thought arrow boards are too high, wanted to be advised about WZ in less than 1 mile ahead, or wanted additional signs were overrepresented.

The driving experience and age were significant factors in facing BDS in TRA. The average age and experience of drivers who had BDS in TRA were less than those who did not have BDS experiences. Among drivers who experienced BDS in TRA, drivers from private carriers, or drivers who perceived that WZ are as hazardous as non-WZ were under-represented. The experience of BDS in TRA was correlated to how drivers perceive the speed limit of 55 mph and how fast they travel through a WZ with a 45 mph speed limit. Those who indicated that the 55 mph speed limit is too slow, and those who travel at speeds above 55 mph in 45 mph speed limit zones were over-represented in experiencing BDS in TRA. A higher than expected percentage of drivers who have had accidents in work zones said that they also have experienced bad situations in TRA. Drivers who indicated the flaggers are visible and brightness of arrow boards is okay were under-represented among those who have experienced BDS in TRA.

Drivers who have experienced BDS in buffer space were over-represented among those who drive flatbed or lowboy trucks, prefer one-lane closure, feel uncomfortable in median crossovers, lack of shoulders or lane width, said flaggers are hard to see, or indicated that there are unclear or confusing signs in work zones.

Drivers who have experienced BDS in work space were over-represented among those who had lower VMT, drove trucks for common carriers, wanted to know about work zones 2 miles or less, had accidents, said that merging to an open lane, median crossovers or lack of shoulders make them feel uncomfortable, traveled below 45 mph or at $51-55 \mathrm{mph}$ in work zones of 45 mph speed limit, or those who did not like the use of cones. However, they were underrepresented among those who were driving trucks for private carriers, or those who drive 46-50 mph in $45-\mathrm{mph}$ speed limit areas. This seems to indicate that those who deviated from the "group" speed end up experiencing BDS in WKS more often.

Drivers who have experienced BDS in termination areas were over-represented in those who said that merging to an open lane, median crossovers, lack of shoulders or lane-closure taper length make them feel uncomfortable, said that flaggers are hard to see or the directions
given by flaggers are confusing, said arrow boards are too high, indicated the presence of unclear or confusing signs in the Illinois work zones, or those who said signs should be added to work zones.

Among the drivers who had accidents in the WZ, those drivers with BDS experience in the entire work zone, in the AWA, in the TRA, or to a large degree in the WKS were overrepresented. For buffer space and termination areas a significant relationship between accident and BDS experiences was not detected. Overall, BDS experience is a good indicator of accidents experience and areas of concerns for the truck drivers.

Based on the annual miles driven in Illinois and U.S. and their ratio, the Illinois-drivers and non-Illinois-drivers were identified and their opinions were compared. Illinois drivers were over-represented in those who thought that 55 mph speed limit in work zones is too fast, usually drove below 45 mph in work zones with a 45 mph speed limit, or had accident(s) in work zones. Illinois drivers were under-represented in those who did not like the use of concrete barriers, in those who said that the lack of shoulders and the lane closure taper length did not make them uncomfortable when driving through work zones. Furthermore, Illinois drivers were underrepresented in those who said that arrow boards are too bright, but were over-represented in those who said that their brightness is okay. Illinois drivers were under-represented in those who said that brightness of CMBs is okay, but were over-represented in those who said that CMBs are too bright.

## RECOMMENDATIONS

- Issues related to flagger's visibility and directions, brightness of arrow boards, speed limit, and unclear/confusing signs need to be investigated in order to determine the nature of the problems and to find possible solutions.
- Methods of improving flagger's visibility and clarity of flagger's directions given should be explored.
- The brightness of arrow boards needs to be examined to improve their effectiveness and/or reduce their disturbing effects.
- Feasibility and effectiveness of adding signs to work zones should be examined, and further studies should be conducted to improve signing lane closures, exit ramps, merging, road
conditions notification, and speed limits.
- Efforts to improve traffic safety in work zones for truck drivers particularly in the transition area and advance warning area should be initiated and their impacts should be evaluated.
- A large number of drivers had concerns about BDS in WZ particularly in advance warning and transition areas. Merging and lane changing behavior of traffic, needs to be studied to find improvement to the current state of practice.
- Drivers with BDS experience wanted additional WZ signs to help them out. Feasibility and effectiveness of adding such signs to WZ needs to be determined.
- More detailed accident data showing the type and location of accidents within work zones needs to be collected.
- Accident exposure rates for work zones needs to be developed in order to evaluate safety and effectiveness of traffic control measures.
- Large truck involvements in work zone accidents needs to be studied to determine their accident characteristics and potential work zone safety improvements.
- Further analyses should be conducted to evaluate the effects of experience (more experienced vs less experienced), truck configurations (single trailer vs double trailer), and to examine the responses from certain sub-groups of participants to specific questions of interest (multivariate analysis).
- Drivers education efforts should be initiated to increase drivers perception of hazard in work zones. They should be directed toward increasing car drivers' perception of hazard in work zones and truck drivers' understanding of work zone traffic control plans.


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## APPENDIX A. Survey Questionnaire

## SURVEY OF PROFESSIONAL TRUCK DRIVERS' OPINIONS ABOUT WORK ZONES

PLEASE CIRCLE THE ITEM(S) THAT BEST ANSWER EACH QUESTION OR FILL IN THE BLANZS. THANK YOU, WE APPRECIATE YOUR HELP.
\%
LOC:

1. HOW LONG HAVE YOU DRIVEN A TRUCK? $\qquad$ years

2a. HOW MANY MILES DID YOU DRIVE A TRUCK LAST YEAR? $\qquad$ miles

2b. HOW MANY OF THOSE MILES WERE IN ILLINOIS? $\qquad$ miles
3. HOW OLD ARE YOU? $\qquad$ years

4a. WHAT TYPE OF TRUCK ARE YOU DRIVING?
A. Bax van
F. Flatbed or Platform
K. Chemical
B. Dump
G. Lowboy
L. Other (specify)
C. Double Bottom
H. Grain
D. Pole
I. Livestock
E. Tanker or Hopper
J. Auto-Transport

4b. WHAT TYPE OF CARRIER IS THE COMPANY YOU CURRENTLY DRIVE FOR?
A. Common
D. Exempt
B. Contract
E. Orher (specify):
C. Private

4c. WHAT IS THE NUMBER OF TRUCKS YOUR COMPANY OPERATES? $\qquad$ trucks

## 5. WHEN DO YOU USUALLY DRIVE A TRUCK?

A. Daytime
B. Nighttime
C. All hours
6. ARE YOU CARRYING LOAD THAT REQUIRES A PERMIT? (CIRCLE ALL THAT APPLY)
A. No
E. Yes - Hazardous materials
B. Yes-overweight
F. Other (specify):
C. Yes-overheight
D. Yes - overwidth
7. HOW MANY MILES IN ADVANCE WOULD YOU LIKE TO FIND OUT ABOUT A WORK ZONE AHEAD?
A. Less than 1
D. 6-10
B. 1-2
C. $\quad 3-5$
E. Other (specify):
8. HOW HAZARDOUS IS DRIVING A TRUCK THROUGH WORK ZONES COMPARED TO NONWORK ZONES?
A. More hazardous
C. About the same
B. Less hazardous
D. I don't know
9. CONSTRUCIION ZONES USUALLY HAVE A MEDIAN CROSSOVER OR ONE-LANE CLOSURE AS SHOWN BELLOW:


Median Crossover


One-Lane Closure

HOW DO COMPARE DRIVING THROUGH THESE 2 CONDITIONS?
A. I prefer driving in median crossover than driving in one-lane closure
B. I prefer driving in one-lane closure than driving in median crossover
C. I have no preference
D. No opinion
15. WHAT DO YOU THINK ABOUT THE FOLLOWING CONTROL DEVICES IN WORK ZONES? (CIRCLE ONE ANSWER FOR EACH ITEM).

|  | VERY HELPFUL | SOMEWHAT HELPFUL | $\begin{aligned} & \text { DO NOT LIEE } \\ & \text { IHEIR USE } \end{aligned}$ | NO OPINION |
| :---: | :---: | :---: | :---: | :---: |
| A. Cones | 1 | 2 | 3 | 4 |
| B. Barricades | 1 | 2 | 3 | 4 |
| C. White Plastic Barricades | 1 | 2 | 3 | 4 |
| D. Concrese Barriers | 1 | 2 | 3 | 4 |
| E. Barrels | 1 | 2 | 3 | 4 |
| F. Tubes | 1 | 2 | 3 | 4 |
| G. Impact Atenuators | 1 | 2 | 3 | 4 |

16a. WHAT DO YOU THINK ABOUT THE HEIGHT OF ARROW BOARDS IN WORK ZONES?
A. Too high
C. The height is okay
B. Too low
D. No opinion

16b. WHAT DO YOU THINK ABOUT THE BRIGHTNESS OF ARROW BOARDS IN WORK ZONES?
A. Too bright
C. Brightness is okay
B. Not bright enough
D. No opinion

17a. WHAT DO YOU THINK ABOUT THE HEIGHT OF CHANGEABLE MESSAGE BOARDS IN WORK ZONES?
A. Too high
C. The height is okay
B. Toolow
D. No opinion

APPENDIX B. Frequency of Responses to Items in the Questionnaire

Question 1: How long have you driven a truck? Answer in number of years. DRIVTIME Frequency Percent Frequency Cumulative Percent

| 0 | 1 | 0.1 | 1 | 0.1 |
| :---: | :---: | :---: | :---: | :---: |
| 0.1 | 3 | 0.4 | 4 | 0.5 |
| 0.2 | 2 | 0.2 | 6 | 0.7 |
| 0.3 | 3 | 0.4 | 9 | 1.1 |
| 0.5 | 5 | 0.6 | 14 | 1.7 |
| 0.8 | 2 | 0.2 | 16 | 1.9 |
| 1 | 16 | 1.9 | 32 | 3.8 |
| 1.3 | 1 | 0.1 | 33 | 4.0 |
| 1.5 | 9 | 1.1 | 42 | 5.0 |
| 1.6 | 1 | 0.1 | 43 | 5.2 |
| 2 | 27 | 3.2 | 70 | 8.4 |
| 2.5 | 6 | 0.7 | 76 | 9.1 |
| 3 | 38 | 4.6 | 114 | 13.7 |
| 3.5 | 3 | 0.4 | 117 | 14.0 |
| 4 | 21 | 2.5 | 138 | 16.6 |
| 4.5 | 4 | 0.5 | 142 | 17.0 |
| 5 | 49 | 5.9 | 191 | 22.9 |
| 5.5 | 1 | 0.1 | 192 | 23.0 |
| 6 | 21 | 2.5 | 213 | 25.6 |
| 6.5 | 1 | 0.1 | 214 | 25.7 |
| 7 | 15 | 1.8 | 229 | 27.5 |
| 7.5 | 2 | 0.2 | 231 | 27.7 |
| 8 | 30 | 3.6 | 261 | 31.3 |
| 9 | 14 | 1.7 | 275 | 33.0 |
| 9.5 | 2 | 0.2 | 277 | 33.3 |
| 10 | 43 | 5.2 | 320 | 38.4 |
| 11 | 12 | 1.4 | 332 | 39.9 |
| 12 | 21 | 2.5 | 353 | 42.4 |
| 13 | 16 | 1.9 | 369 | 44.3 |
| 14 | 14 | 1.7 | 383 | 46.0 |
| 15 | 53 | 6.4 | 436 | 52.3 |
| 16 | 17 | 2.0 | 453 | 54.4 |
| 17 | 22 | 2.6 | 475 | 57.0 |
| 18 | 21 | 2.5 | 496 | 59.5 |
| 19 | 4 | 0.5 | 500 | 60.0 |
| 20 | 55 | 6.6 | 555 | 66.6 |
| 21 | 18 | 2.2 | 573 | 68.8 |
| 22 | 23 | 2.8 | 596 | 71.5 |
| 23 | 24 | 2.9 | 620 | 74.4 |
| 24 | 6 | 0.7 | 626 | 75.2 |
| 25 | 34 | 4.1 | 660 | 79.2 |
| 26 | 17 | 2.0 | 677 | 81.3 |
| 27 | 15 | 1.8 | 692 | 83.1 |
| 28 | 11 | 1.3 | 703 | 84.4 |
| 29 | 13 | 1.6 | 716 | 86.0 |
| 30 | 28 | 3.4 | 744 | 89.3 |
| 31 | 9 | 1.1 | 753 | 90.4 |
| 32 | 14 | 1.7 | 767 | 92.1 |
| 33 | 12 | 1.4 | 779 | 93.5 |
| 34 | 7 | 0.8 | 786 | 94.4 |
| 35 | 10 | 1.2 | 796 | 95.6 |
| 36 | 4 | 0.5 | 800 | 96.0 |
| 37 | 2 | 0.2 | 802 | 96.3 |
| 38 | 6 | 0.7 | 808 | 97.0 |

It should be noted that these are the "raw" frequencies and used in most of the statistical analyses. However, in some occasions re-grouping were done to obtain enough observations for statistical analyses purpose.

Please note that codes $1,2,3,4, \ldots$ correspond to responses $\mathrm{A}, \mathrm{B}, \mathrm{C}, \mathrm{D}, \ldots$ in the questionnaire. When the number of the response choices was smaller than 10 , codes like 12, $123,34, \ldots$ indicate that the responses A and $\mathrm{B}, \mathrm{A}$ and B and C , and C and D were selected in the questionnaire.

| 108 | 1 | 0.1 | 387 | 47.4 |
| :---: | :---: | :---: | :---: | :---: |
| 109 | 1 | 0.1 | 388 | 47.5 |
| 110 | 43 | 5.3 | 431 | 52.8 |
| 112 | 4 | 0.5 | 435 | 53.3 |
| 113 | 1 | 0.1 | 436 | 53.4 |
| 115 | 17 | 2.1 | 453 | 55.5 |
| 116 | 2 | 0.2 | 455 | 55.8 |
| 117 | 2 | 0.2 | 457 | 56.0 |
| 118 | 3 | 0.4 | 460 | 56.4 |
| 119 | 1 | 0.1 | 461 | 56.5 |
| 120 | 79 | 9.7 | 540 | 66.2 |
| 121 | 3 | 0.4 | 543 | 66.5 |
| 122 | 3 | 0.4 | 546 | 66.9 |
| 123 | 1 | 0.1 | 547 | 67.0 |
| 125 | 41 | 5.0 | 588 | 72.1 |
| 126 | 1 | 0.1 | 589 | 72.2 |
| 127 | 2 | 0.2 | 591 | 72.4 |
| 128 | 1 | 0.1 | 592 | 72.5 |
| 129 | 1 | 0.1 | 593 | 72.7 |
| 130 | 41 | 5.0 | 634 | 77.7 |
| 131 | 1 | 0.1 | 635 | 77.8 |
| 132 | 2 | 0.2 | 637 | 78.1 |
| 133 | 1 | 0.1 | 638 | 78.2 |
| 135 | 15 | 1.8 | 653 | 80.0 |
| 136 | 3 | 0.4 | 656 | 80.4 |
| 137 | 2 | 0.2 | 658 | 80.6 |
| 138 | 1 | 0.1 | 659 | 80.8 |
| 140 | 26 | 3.2 | 685 | 83.9 |
| 141 | 3 | 0.4 | 688 | 84.3 |
| 142 | 1 | 0.1 | 689 | 84.4 |
| 144 | 3 | 0.4 | 692 | 84.8 |
| 145 | 4 | 0.5 | 696 | 85.3 |
| 147 | 3 | 0.4 | 699 | 85.7 |
| 150 | 52 | 6.4 | 751 | 92.0 |
| 155 | 2 | 0.2 | 753 | 92.3 |
| 156 | 2 | 0.2 | 755 | 92.5 |
| 159 | 1 | 0.1 | 756 | 92.6 |
| 160 | 10 | 1.2 | 766 | 93.9 |
| 161 | 1 | 0.1 | 767 | 94.0 |
| 165 | 3 | 0.4 | 770 | 94.4 |
| 168 | 1 | 0.1 | 771 | 94.5 |
| 175 | 6 | 0.7 | 777 | 95.2 |
| 180 | 5 | 0.6 | 782 | 95.8 |
| 185 | 1 | 0.1 | 783 | 96.0 |
| 190 | 1 | 0.1 | 784 | 96.1 |
| 194 | 2 | 0.2 | 786 | 96.3 |
| 200 | 16 | 2.0 | 802 | 98.3 |
| 210 | 2 | 0.2 | 804 | 98.5 |
| 240 | 1 | 0.1 | 805 | 98.7 |
| 250 | 5 | 0.6 | 810 | 99.3 |
| 260 | 4 | 0.5 | 814 | 99.8 |
| 280 | 1 | 0.1 | 815 | 99.9 |
| 290 | 1 | 0.1 | 816 | 100.0 |
| Frequency Missing $=18$ |  |  |  |  |

[^0]| 2 | 23 | 3.2 | 74 | 10.3 |
| :---: | :---: | :---: | :---: | :---: |
| 2.5 | 1 | 0.1 | 75 | 10.5 |
| 3 | 16 | 2.2 | 91 | 12.7 |
| 4 | 9 | 1.3 | 100 | 13.9 |
| 5 | 42 | 5.9 | 142 | 19.8 |
| 6 | 11 | 1.5 | 153 | 21.3 |
| 7 | 6 | 0.8 | 159 | 22.2 |
| 8 | 15 | 2.1 | 174 | 24.3 |
| 9 | 5 | 0.7 | 179 | 25.0 |
| 10 | 82 | 11.4 | 261 | 36.4 |
| 11 | 3 | 0.4 | 264 | 36.8 |
| 12 | 19 | 2.6 | 283 | 39.5 |
| 13 | 4 | 0.6 | 287 | 40.0 |
| 14 | 3 | 0.4 | 290 | 40.4 |
| 15 | 35 | 4.9 | 325 | 45.3 |
| 16 | 3 | 0.4 | 328 | 45.7 |
| 18 | 8 | 1.1 | 336 | 46.9 |
| 20 | 78 | 10.9 | 414 | 57.7 |
| 21 | 3 | 0.4 | 417 | 58.2 |
| 22 | 2 | 0.3 | 419 | 58.4 |
| 23 | 3 | 0.4 | 422 | 58.9 |
| 24 | 3 | 0.4 | 425 | 59.3 |
| 25 | 48 | 6.7 | 473 | 66.0 |
| 26 | 1 | 0.1 | 474 | 66.1 |
| 27 | 1 | 0.1 | 475 | 66.2 |
| 28 | 2 | 0.3 | 477 | 66.5 |
| 30 | 57 | 7.9 | 534 | 74.5 |
| 31 | 1 | 0.1 | 535 | 74.6 |
| 32 | 1 | 0.1 | 536 | 74.8 |
| 33 | 7 | 1.0 | 543 | 75.7 |
| 35 | 21 | 2.9 | 564 | 78.7 |
| 36 | 1 | 0.1 | 565 | 78.8 |
| 37 | 2 | 0.3 | 567 | 79.1 |
| 38 | 1 | 0.1 | 568 | 79.2 |
| 40 | 36 | 5.0 | 604 | 84.2 |
| 41 | 2 | 0.3 | 606 | 84.5 |
| 45 | 7 | 1.0 | 613 | 85.5 |
| 46 | 1 | 0.1 | 614 | 85.6 |
| 47 | 2 | 0.3 | 616 | 85.9 |
| 48 | 1 | 0.1 | 617 | 86.1 |
| 49 | 1 | 0.1 | 618 | 86.2 |
| 50 | 23 | 3.2 | 641 | 89.4 |
| 53 | 1 | 0.1 | 642 | 89.5 |
| 55 | 4 | 0.6 | 646 | 90.1 |
| 57 | 1 | 0.1 | 647 | 90.2 |
| 59 | 1 | 0.1 | 648 | 90.4 |
| 60 | 14 | 2.0 | 662 | 92.3 |
| 65 | 5 | 0.7 | 667 | 93.0 |
| 68 | 1 | 0.1 | 668 | 93.2 |
| 70 | 6 | 0.8 | 674 | 94.0 |
| 74 | 1 | 0.1 | 675 | 94.1 |
| 75 | 11 | 1.5 | 686 | 95.7 |
| 80 | 9 | 1.3 | 695 | 96.9 |
| 83 | 1 | 0.1 | 696 | 97.1 |
| 84 | 1 | 0.1 | 697 | 97.2 |
| 85 | 2 | 0.3 | 699 | 97.5 |
| 90 | 2 | 0.3 | 701 | 97.8 |
| 94 | 1 | 0.1 | 702 | 97.9 |
| 95 | 1 | 0.1 | 703 | 98.0 |
| 100 | 9 | 1.3 | 712 | 99.3 |
| 110 | 1 | 0.1 | 713 | 99.4 |
| 120 | 3 | 0.4 | 716 | 99.9 |

Question 3: How old are you? Answer in number of years.

| AGE | Frequency | Percent | Cumulative Frequency | Cumulative Percent |
| :---: | :---: | :---: | :---: | :---: |
| 20 | 1 | 0.1 | 1 | 0.1 |
| 22 | 1 | 0.1 | 2 | 0.2 |
| 23 | 7 | 0.8 | 9 | 1.1 |
| 24 | 13 | 1.6 | 22 | 2.6 |
| 25 | 14 | 1.7 | 36 | 4.3 |
| 26 | 9 | 1.1 | 45 | 5.4 |
| 27 | 11 | 1.3 | 56 | 6.7 |
| 28 | 15 | 1.8 | 71 | 8.5 |
| 29 | 19 | 2.3 | 90 | 10.8 |
| 30 | 17 | 2.0 | 107 | 12.8 |
| 31 | 13 | 1.6 | 120 | 14.4 |
| 32 | 26 | 3.1 | 146 | 17.5 |
| 33 | 28 | 3.4 | 174 | 20.9 |
| 34 | 19 | 2.3 | 193 | 23.1 |
| 35 | 25 | 3.0 | 218 | 26.1 |
| 36 | 21 | 2.5 | 239 | 28.7 |
| 37 | 23 | 2.8 | 262 | 31.4 |
| 38 | 33 | 4.0 | 295 | 35.4 |
| 39 | 28 | 3.4 | 323 | 38.7 |
| 40 | 35 | 4.2 | 358 | 42.9 |
| 41 | 25 | 3.0 | 383 | 45.9 |
| 42 | 28 | 3.4 | 411 | 49.3 |
| 43 | 31 | 3.7 | 442 | 53.0 |
| 44 | 22 | 2.6 | 464 | 55.6 |
| 45 | 22 | 2.6 | 486 | 58.3 |
| 46 | 28 | 3.4 | 514 | 61.6 |
| 47 | 20 | 2.4 | 534 | 64.0 |
| 48 | 23 | 2.8 | 557 | 66.8 |
| 49 | 24 | 2.9 | 581 | 69.7 |
| 50 | 32 | 3.8 | 613 | 73.5 |
| 51 | 25 | 3.0 | 638 | 76.5 |
| 52 | 24 | 2.9 | 662 | 79.4 |
| 53 | 26 | 3.1 | 688 | 82.5 |
| 54 | 20 | 2.4 | 708 | 84.9 |
| 55 | 25 | 3.0 | 733 | 87.9 |
| 56 | 17 | 2.0 | 750 | 89.9 |
| 57 | 20 | 2.4 | 770 | 92.3 |
| 58 | 20 | 2.4 | 790 | 94.7 |
| 59 | 8 | 1.0 | 798 | 95.7 |
| 60 | 15 | 1.8 | 813 | 97.5 |
| 61 | 4 | 0.5 | 817 | 98.0 |
| 62 | 9 | 1.1 | 826 | 99.0 |
| 63 | 5 | 0.6 | 831 | 99.6 |
| 64 | 2 | 0.2 | 833 | 99.9 |
| 68 | 1 | 0.1 | 834 | 100.0 |

Question 4a: What type of truck are you driving? Coded answer. Cumulative Cumulative TRUCTYPE Frequency Percent Frequency Percent

| 1 | 459 | 55.0 | 459 | 55.0 |
| :---: | ---: | ---: | ---: | ---: |
| 2 | 16 | 1.9 | 475 | 57.0 |
| 3 | 55 | 6.6 | 530 | 63.5 |


| 4 |  | 0.2 | 532 | 63.8 |
| ---: | ---: | ---: | ---: | ---: |
| 5 | 60 | 7.2 | 592 | 71.0 |
| 6 | 110 | 13.2 | 702 | 84.2 |
| 7 | 21 | 2.5 | 723 | 86.7 |
| 8 | 14 | 1.7 | 737 | 88.4 |
| 9 | 11 | 1.3 | 748 | 89.7 |
| 10 | 17 | 2.0 | 765 | 91.7 |
| 11 | 10 | 1.2 | 775 | 92.9 |
| 12 | 1 | 0.1 | 776 | 93.0 |
| 13 | 58 | 7.0 | 834 | 100.0 |

Question 4b: What type of carrier is the company you currently drive for? Coded answer.

| CARRIER | Frequency | Percent | Cumulative <br> Frequency | Cumulative <br> Percent |
| ---: | :---: | :---: | :---: | :---: |
| 1 | 514 | 61.9 | 514 | 61.9 |
| 2 | 150 | 18.1 | 664 | 79.9 |
| 3 | 103 | 12.4 | 767 | 92.3 |
| 4 | 18 | 2.2 | 785 | 94.5 |
| 6 | 19 | 2.3 | 804 | 96.8 |
| 12 | 16 | 1.9 | 820 | 98.7 |
| 13 | 3 | 0.4 | 823 | 99.0 |
| 14 | 3 | 0.4 | 826 | 99.4 |
| 23 | 2 | 0.2 | 828 | 99.6 |
| 24 | 1 | 0.1 | 829 | 99.8 |
| 35 | 1 | 0.1 | 830 | 99.9 |
| 124 | 1 | 0.1 | 831 | 100.0 |

Question 4c: What is the number of trucks your company operates? Answer in actual number of trucks.

| NUMTRUCX | Frequency | Percent | Cumulative Frequency | Cumulative Percent |
| :---: | :---: | :---: | :---: | :---: |
| 0 | 1 | 0.1 | 1 | 0.1 |
| 1 | 13 | 1.7 | 14 | 1.8 |
| 2 | 10 | 1.3 | 24 | 3.1 |
| 3 | 10 | 1.3 | 34 | 4.4 |
| 4 | 14 | 1.8 | 48 | 6.2 |
| 5 | 8 | 1.0 | 56 | 7.2 |
| 6 | 5 | 0.6 | 61 | 7.8 |
| 7 | 4 | 0.5 | 65 | 8.3 |
| 8 | 10 | 1.3 | 75 | 9.6 |
| 9 | 5 | 0.6 | 80 | 10.3 |
| 10 | 12 | 1.5 | 92 | 11.8 |
| 11 | 1 | 0.1 | 93 | 11.9 |
| 12 | 11 | 1.4 | 104 | 13.4 |
| 13 | 3 | 0.4 | 107 | 13.7 |
| 14 | 5 | 0.6 | 112 | 14.4 |
| 15 | 13 | 1.7 | 125 | 16.0 |
| 16 | 2 | 0.3 | 127 | 16.3 |
| 17 | 4 | 0.5 | 131 | 16.8 |
| 18 | 7 | 0.9 | 138 | 17.7 |
| 20 | 30 | 3.9 | 168 | 21.6 |
| 21 | 1 | 0.1 | 169 | 21.7 |
| 22 | 1 | 0.1 | 170 | 21.8 |
| 23 | 1 | 0.1 | 171 | 22.0 |
| 24 | 2 | 0.3 | 173 | 22.2 |
| 25 | 11 | 1.4 | 184 | 23.6 |


| 26 | 6 | 0.8 | 190 | 24.4 |
| :---: | :---: | :---: | :---: | :---: |
| 27 | 2 | 0.3 | 192 | 24.6 |
| 30 | 29 | 3.7 | 221 | 28.4 |
| 32 | 2 | 0.3 | 223 | 28.6 |
| 35 | 7 | 0.9 | 230 | 29.5 |
| 36 | 2 | 0.3 | 232 | 29.8 |
| 38 | 2 | 0.3 | 234 | 30.0 |
| 40 | 16 | 2.1 | 250 | 32.1 |
| 42 | 2 | 0.3 | 252 | 32.3 |
| 45 | 4 | 0.5 | 256 | 32.9 |
| 48 | 2 | 0.3 | 258 | 33.1 |
| 50 | 19 | 2.4 | 277 | 35.6 |
| 52 | 1 | 0.1 | 278 | 35.7 |
| 56 | 2 | 0.3 | 280 | 35.9 |
| 57 | 1 | 0.1 | 281 | 36.1 |
| 60 | 9 | 1.2 | 290 | 37.2 |
| 65 | 5 | 0.6 | 295 | 37.9 |
| 68 | 1 | 0.1 | 296 | 38.0 |
| 70 | 7 | 0.9 | 303 | 38.9 |
| 75 | 9 | 1.2 | 312 | 40.1 |
| 80 | 12 | 1.5 | 324 | 41.6 |
| 85 | 5 | 0.6 | 329 | 42.2 |
| 90 | 7 | 0.9 | 336 | 43.1 |
| 97 | 2 | 0.3 | 338 | 43.4 |
| 100 | 34 | 4.4 | 372 | 47.8 |
| 101 | 1 | 0.1 | 373 | 47.9 |
| 102 | 1 | 0.1 | 374 | 48.0 |
| 106 | 2 | 0.3 | 376 | 48.3 |
| 110 | 1 | 0.1 | 377 | 48.4 |
| 112 | 1 | 0.1 | 378 | 48.5 |
| 116 | 1 | 0.1 | 379 | 48.7 |
| 120 | 2 | 0.3 | 381 | 48.9 |
| 125 | 3 | 0.4 | 384 | 49.3 |
| 127 | 1 | 0.1 | 385 | 49.4 |
| 130 | 5 | 0.6 | 390 | 50.1 |
| 132 | 2 | 0.3 | 392 | 50.3 |
| 140 | 3 | 0.4 | 395 | 50.7 |
| 148 | 1 | 0.1 | 396 | 50.8 |
| 150 | 15 | 1.9 | 411 | 52.8 |
| 160 | 1 | 0.1 | 412 | 52.9 |
| 161 | 1 | 0.1 | 413 | 53.0 |
| 165 | 1 | 0.1 | 414 | 53.1 |
| 175 | 1 | 0.1 | 415 | 53.3 |
| 180 | 1 | 0.1 | 416 | 53.4 |
| 185 | 1 | 0.1 | 417 | 53.5 |
| 200 | 25 | 3.2 | 442 | 56.7 |
| 210 | 1 | 0.1 | 443 | 56.9 |
| 230 | 1 | 0.1 | 444 | 57.0 |
| 250 | 15 | 1.9 | 459 | 58.9 |
| 260 | 1 | 0.1 | 460 | 59.1 |
| 265 | 1 | 0.1 | 461 | 59.2 |
| 275 | 1 | 0.1 | 462 | 59.3 |
| 280 | 2 | 0.3 | 464 | 59.6 |
| 300 | 21 | 2.7 | 485 | 62.3 |
| 332 | 1 | 0.1 | 486 | 62.4 |
| 350 | 7 | 0.9 | 493 | 63.3 |
| 375 | 1 | 0.1 | 494 | 63.4 |
| 400 | 11 | 1.4 | 505 | 64.8 |
| 420 | 2 | 0.3 | 507 | 65.1 |
| 425 | 1 | 0.1 | 508 | 65.2 |
| 450 | 4 | 0.5 | 512 | 65.7 |
| 460 | 1 | 0.1 | 513 | 65.9 |


| 475 | 2 | 0.3 | 515 | 66.1 |
| :---: | :---: | :---: | :---: | :---: |
| 480 | 1 | 0.1 | 516 | 66.2 |
| 500 | 42 | 5.4 | 558 | 71.6 |
| 510 | 1 | 0.1 | 559 | 71.8 |
| 525 | 1 | 0.1 | 560 | 71.9 |
| 530 | 2 | 0.3 | 562 | 72.1 |
| 538 | 1 | 0.1 | 563 | 72.3 |
| 550 | 7 | 0.9 | 570 | 73.2 |
| 560 | 1 | 0.1 | 571 | 73.3 |
| 574 | 1 | 0.1 | 572 | 73.4 |
| 575 | 1 | 0.1 | 573 | 73.6 |
| 600 | 13 | 1.7 | 586 | 75.2 |
| 650 | 3 | 0.4 | 589 | 75.6 |
| 700 | 7 | 0.9 | 596 | 76.5 |
| 750 | 4 | 0.5 | 600 | 77.0 |
| 800 | 14 | 1.8 | 614 | 78.8 |
| 850 | 4 | 0.5 | 618 | 79.3 |
| 875 | 1 | 0.1 | 619 | 79.5 |
| 900 | 6 | 0.8 | 625 | 80.2 |
| 950 | 1 | 0.1 | 626 | 80.4 |
| 975 | 1 | 0.1 | 627 | 80.5 |
| 1000 | 21 | 2.7 | 648 | 83.2 |
| 1100 | 2 | 0.3 | 650 | 83.4 |
| 1200 | 7 | 0.9 | 657 | 84.3 |
| 1251 | 1 | 0.1 | 658 | 84.5 |
| 1300 | 2 | 0.3 | 660 | 84.7 |
| 1400 | 2 | 0.3 | 662 | 85.0 |
| 1500 | 14 | 1.8 | 676 | 86.8 |
| 1600 | 2 | 0.3 | 678 | 87.0 |
| 1700 | 1 | 0.1 | 679 | 87.2 |
| 1800 | 2 | 0.3 | 681 | 87.4 |
| 1900 | 1 | 0.1 | 682 | 87.5 |
| 2000 | 15 | 1.9 | 697 | 89.5 |
| 2513 | 1 | 0.1 | 698 | 89.6 |
| 3000 | 17 | 2.2 | 715 | 91.8 |
| 3300 | 1 | 0.1 | 716 | 91.9 |
| 3350 | 1 | 0.1 | 717 | 92.0 |
| 3500 | 8 | 1.0 | 725 | 93.1 |
| 3800 | 1 | 0.1 | 726 | 93.2 |
| 4000 | 7 | 0.9 | 733 | 94.1 |
| 4500 | 2 | 0.3 | 735 | 94.4 |
| 5000 | 9 | 1.2 | 744 | 95.5 |
| 6000 | 6 | 0.8 | 750 | 96.3 |
| 6500 | 1 | 0.1 | 751 | 96.4 |
| 7000 | 6 | 0.8 | 757 | 97.2 |
| 7500 | 1 | 0.1 | 758 | 97.3 |
| 8000 | 5 | 0.6 | 763 | 97.9 |
| 9000 | 4 | 0.5 | 767 | 98.5 |
| 9500 | 1 | 0.1 | 768 | 98.6 |
| 0000 | 2 | 0.3 | 770 | 98.8 |
| 1000 | 3 | 0.4 | 773 | 99.2 |
| 2000 | 2 | 0.3 | 775 | 99.5 |
| 8000 | 3 | 0.4 | 778 | 99.9 |
| 25000 | 1 | 0.1 | 779 | 100.0 |
|  | Freq | Missing $=55$ |  |  |

Question 5: When do you usually drive a truck? Coded answer. Cumulative Cumulative DRDAYNIG Frequency Percent Frequency Percent

| $-\cdots-10.1$ | 84 | 10.1 | 84 | 10.1 |
| :---: | :---: | :---: | :---: | :---: |


| 2 | 16 | 1.9 | 100 |
| :--- | :--- | :---: | ---: |
| 3 | 733 | 88.0 | 12.0 |
|  | Frequency Missing $=1$ |  |  |

Question 6: Are you carrying load that requires a permit? Coded answer.

| LOAD | Frequency | Percent | Cumulative <br> Frequency | Cumulative <br> Percent |
| ---: | ---: | ---: | ---: | ---: |
| 1 | 651 | 78.6 | 651 | 78.6 |
| 2 | 2 | 0.2 | 653 | 78.9 |
| 4 | 7 | 0.8 | 660 | 79.7 |
| 5 | 124 | 15.0 | 784 | 94.7 |
| 7 | 8 | 1.0 | 792 | 95.7 |
| 23 | 2 | 0.2 | 794 | 95.9 |
| 34 | 6 | 0.7 | 800 | 96.6 |
| 45 | 3 | 0.4 | 803 | 97.0 |
| 234 | 17 | 2.1 | 820 | 99.0 |
| 457 | 1 | 0.1 | 821 | 99.2 |
| 2345 | 7 | 0.8 | 828 | 100.0 |
|  | Frequency Missing $=6$ |  |  |  |

Question 7: How many miles in advance would you like to find out about a work zone ahead? Coded answer.

| MILEADV | Frequency | Percent | Cumulative <br> Frequency | Cumulative <br> Percent |
| :---: | :---: | :---: | :---: | ---: |
| 1 | 21 | 2.5 | 21 | 2.5 |
| 2 | 277 | 33.5 | 298 | 36.0 |
| 3 | 392 | 47.3 | 690 | 83.3 |
| 4 | 119 | 14.4 | 809 | 97.7 |
| 6 | 18 | 2.2 | 827 | 99.9 |
| 7 | 1 | 0.1 | 828 | 100.0 |

Question 8: How hazardous is driving a truck through work zones compared to nonwork zones? Coded answers.

| WZHAZARD | Frequency | Percent | Cumulative <br> Frequency | Cumulative <br> Percent |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 750 | 90.1 | 750 | 90.1 |
| 2 | 3 | 0.4 | 753 | 90.5 |
| 3 | 70 | 8.4 | 823 | 98.9 |
| 4 | 9 | 1.1 | 832 | 100.0 |

Question 9: Construction zones usually have a median crossover or one-lane closure as shown. How do You compare driving through these 2 conditions? Coded answer.

| WZCHARAC | Frequency | Percent | Cumulative <br> Frequency | Cumulative <br> Percent |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 295 | 35.5 | 295 | 35.5 |
| 2 | 273 | 32.8 | 568 | 68.3 |
| 3 | 244 | 29.3 | 812 | 97.6 |
| 4 | 20 | 2.4 | 832 | 100.0 |

Question 10a: Does merging to an open lane make you feel uncomfortable when you drive through work zones? Coded answer.

| MERGE | Frequency | Percent | Cumulative <br> Frequency | Cumulative <br> Percent |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 385 | 47.1 | 385 | 47.1 |
| 2 | 259 | 31.7 | 644 | 78.8 |
| 3 | 146 | 17.9 | 790 | 96.7 |
| 4 | 27 | 3.3 | 817 | 100.0 |

Question 10b: Do median crossovers make you feel uncomfortable when fou drive through work zones? Coded answer.

| MEDCROS | Frequency | Percent | Cumulative <br> Frequency | Cumulative <br> Percent |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 316 | 38.8 | 316 | 38.8 |
| 2 | 304 | 37.3 | 620 | 76.1 |
| 3 | 176 | 21.6 | 796 | 97.7 |
| 4 | 19 | 2.3 | 815 | 100.0 |

Question 10c: Does lack of shoulders make you feel uncomfoxtable when you drive through work zones? Coded answer.

| SHOULDER | Frequency | Percent | Cumulative <br> Frequency | Cumulative <br> Percent |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 104 | 12.7 | 104 | 12.7 |
| 2 | 268 | 32.7 | 372 | 45.4 |
| 3 | 438 | 53.4 | 810 | 98.8 |
| 4 | 10 | 1.2 | 820 | 100.0 |

Question 10d: Does pavement edge dropoff make you feel uncomfortable when you drive through work zones? Coded answer.

| DROPOFF | Frequency | Percent | Cumulative <br> Frequency | Cumulative <br> Percent |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 88 | 10.7 | 88 | 10.7 |
| 2 | 213 | 25.8 | 301 | 36.5 |
| 3 | 513 | 62.3 | 814 | 98.8 |
| 4 | 10 | 1.2 | 824 | 100.0 |

Question 10e: Do loose construction materials on open lane make you feel uncomfortable when you drive through work zones? Coded answer.

Cumulative Cumulative

| LOOSEMAT | Frequency | Percent | Frequency | Percent |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 100 | 12.2 | 100 | 12.2 |
| 2 | 243 | 29.5 | 343 | 41.7 |
| 3 | 472 | 57.4 | 815 | 99.0 |
| 4 | 8 | 1.0 | 823 | 100.0 |

Question 10f: Does blowing dirt or dust make you feel unconfortable when you drive through work zones? Coded answer.

| DIRT | Frequency | Percent | Cumulative <br> Frequency | Cumulative <br> Percent |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 150 | 18.3 | 150 | 18.3 |
| 2 | 378 | 46.0 | 528 | 64.3 |
| 3 | 278 | 33.9 | 806 | 98.2 |
| 4 | 15 | 1.8 | 821 | 100.0 |
|  | Frequency Missing $=13$ |  |  |  |

Question 10 g : Does lane width make You feel uncomfortable when you drive through work zones? Coded answer.

| LNWIDTH | Frequency | Percent | Cumulative <br> Frequency | Cumulative <br> Percent |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 114 | 13.9 | 114 | 13.9 |
| 2 | 326 | 39.6 | 440 | 53.5 |
| 3 | 371 | 45.1 | 811 | 98.5 |
| 4 | 12 | 1.5 | 823 | 100.0 |

Question 10h: Does driving in "S" curves make you feel uncomfortable when you drive through work zones? Coded answer.

| SCURVE | Frequency | Percent | Cumulative <br> Frequency | Cumulative <br> Percent |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 249 | 30.4 | 249 | 30.4 |
| 2 | 385 | 47.1 | 634 | 77.5 |
| 3 | 164 | 20.0 | 798 | 97.6 |
| 4 | 20 | 2.4 | 818 | 100.0 |

Question 10i: Does lane closure taper length make Fou feel uncomfortable when You drive through work zones? Coded answer.

| TAPLENGT | Frequency | Percent | Cumulative <br> Frequency | Cumulative <br> Percent |
| ---: | :---: | :---: | :---: | :---: |
| 1 | 316 | 38.8 | 316 | 38.8 |
| 2 | 304 | 37.3 | 620 | 76.1 |
| 3 | 176 | 21.6 | 796 | 97.7 |
| 4 | 19 | 2.3 | 815 | 100.0 |

Question 11a: What do Fou think about the speed limit of 55 mph in work zones? Coded answer.

| SPDLA | Frequency | Percent | Cumulative <br> Frequency | Cumulative <br> Percent |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 69 | 8.4 | 69 | 8.4 |
| 2 | 207 | 25.2 | 276 | 33.6 |
| 3 | 510 | 62.0 | 786 | 95.6 |
| 4 | 36 | 4.4 | 822 | 100.0 |
|  | Frequency Missing $=12$ |  |  |  |

Question 11b: In a work zone with a 45 mph speek limit, how fast do you usually drive? Coded answer.
SPDLB Frequency Percent Frequency Cumulative

| 1 | 155 | 18.7 | 155 | 18.7 |
| :---: | :---: | :---: | :---: | :---: |
| 2 | 247 | 29.7 | 402 | 48.4 |
| 3 | 279 | 33.6 | 681 | 81.9 |
| 4 | 128 | 15.4 | 809 | 97.4 |
| 5 | 18 | 2.2 | 827 | 99.5 |
| 6 | 4 | 0.5 | 831 | 100.0 |
|  | Frequency Missing $=3$ |  |  |  |

Question 12: If you have experienced any bad driving situations in work zones, mark in the following sketch their locations. Coded answer.

| BADSIT | Frequency | Percent | Cumulative Frequency | Cumulative Percent |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 92 | 16.7 | 92 | 16.7 |
| 2 | 172 | 31.3 | 264 | 48.0 |
| 3 | 15 | 2.7 | 279 | 50.7 |
| 4 | 26 | 4.7 | 305 | 55.5 |
| 5 | 3 | 0.5 | 308 | 56.0 |
| 12 | 64 | 11.6 | 372 | 67.6 |
| 13 | 1 | 0.2 | 373 | 67.8 |
| 14 | 15 | 2.7 | 388 | 70.5 |
| 15 | 7 | 1.3 | 395 | 71.8 |
| 23 | 14 | 2.5 | 409 | 74.4 |
| 24 | 25 | 4.5 | 434 | 78.9 |
| 25 | 50 | 9.1 | 484 | 88.0 |
| 34 | 11 | 2.0 | 495 | 90.0 |
| 35 | 1 | 0.2 | 496 | 90.2 |
| 45 | 1 | 0.2 | 497 | 90.4 |
| 123 | 6 | 1.1 | 503 | 91.5 |
| 125 | 4 | 0.7 | 507 | 92.2 |
| 134 | 2 | 0.4 | 509 | 92.5 |
| 135 | 1 | 0.2 | 510 | 92.7 |
| 234 | 12 | 2.2 | 522 | 94.9 |
| 235 | 2 | 0.4 | 524 | 95.3 |
| 245 | 7 | 1.3 | 531 | 96.5 |
| 1234 | 3 | 0.5 | 534 | 97.1 |
| 1235 | 1 | 0.2 | 535 | 97.3 |
| 1245 | 2 | 0.4 | 537 | 97.6 |
| 2345 | 6 | 1.1 | 543 | 98.7 |
| 12345 | 7 | 1.3 | 550 | 100.0 |
| Frequency Missing $=284$ |  |  |  |  |

Question 13: If you have had any accidents in work zones, mark in the following sketch their locations. Coded answer.

| ACCID | Frequency | Percent | Cumulative <br> Frequency | Cumulative <br> Percent |
| ---: | :---: | ---: | ---: | ---: |
| 1 | 13 | 25.5 | 13 | 25.5 |
| 2 | 19 | 37.3 | 32 | 62.7 |
| 3 | 2 | 3.9 | 34 | 66.7 |
| 4 | 4 | 7.8 | 38 | 74.5 |
| 5 | 5 | 9.8 | 43 | 84.3 |
| 12 | 2 | 3.9 | 45 | 88.2 |
| 13 | 1 | 2.0 | 46 | 90.2 |
| 14 | 1 | 2.0 | 47 | 92.2 |
| 23 | 1 | 2.0 | 48 | 94.1 |
| 24 | 3 | 5.9 | 51 | 100.0 |

Question 14a: What do You think about the visibility of the flaggers in work zones? Coded answer.

| FLAGVIS | Frequency | Percent | Cumulative <br> Frequency | Cumulative <br> Percent |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 156 | 18.8 | 156 | 18.8 |
| 2 | 366 | 44.2 | 522 | 63.0 |
| 3 | 266 | 32.1 | 788 | 95.2 |
| 4 | 40 | 4.8 | 828 | 100.0 |

Question 14b: What do you think about the directions given by flaggers in work zones? Coded answer.

| FLAGDIR | Frequency | Percent | Cumulative <br> Frequency | Cumulative <br> Percent |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 383 | 46.1 | 383 | 46.1 |
| 2 | 310 | 37.3 | 693 | 83.4 |
| 3 | 102 | 12.3 | 795 | 95.7 |
| 4 | 36 | 4.3 | 831 | 100.0 |

Question 15a: What do You think about cones in work zones? Coded answer. Cumulative Cumulative
CONES Frequency Percent Frequency Percent

| 1 | 368 | 44.4 | 368 | 44.4 |
| ---: | ---: | ---: | ---: | ---: |
| 2 | 334 | 40.3 | 702 | 84.7 |
| 3 | 105 | 12.7 | 807 | 97.3 |
| 4 | 22 | 2.7 | 829 | 100.0 |

Question 15b: What do You think about barricades in work zones? Coded answer. Cumulative Cumulative

| BARR | Frequency | Percent | Frequency | Percent |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 343 | 41.5 | 343 | 41.5 |
| 2 | 283 | 34.3 | 626 | 75.8 |
| 3 | 181 | 21.9 | 807 | 97.7 |
| 4 | 19 | 2.3 | 826 | 100.0 |

Question 15c: What do you think about white plastic barricades in work zones? Coded answer.

| WHBARR | Frequency | Percent | Cumulative <br> Frequency | Cumulative <br> Percent |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 364 | 44.3 | 364 | 44.3 |
| 2 | 313 | 38.1 | 677 | 82.4 |
| 3 | 104 | 12.7 | 781 | 95.0 |
| 4 | 41 | 5.0 | 822 | 100.0 |

Question 15d: What do You think about concrete barriers in work zones? Coded answer.
CONCBAR Frequency Percent Frequency Cumulative

| 1 | 448 | 54.0 | 448 | 54.0 |
| :---: | :---: | :---: | :---: | ---: |
| 2 | 133 | 16.0 | 581 | 70.0 |
| 3 | 232 | 28.0 | 813 | 98.0 |
| 4 | 17 | 2.0 | 830 | 100.0 |

Question 15e: What do you think about barrels in work zones? Coded answer.

| BARREL | Frequency | Percent | Cumulative <br> Frequency | Cumulative <br> Percent |
| ---: | ---: | :---: | ---: | :--- |
| 1 | 366 | 44.3 | 366 | 44.3 |
| 2 | 289 | 34.9 | 655 | 79.2 |
| 3 | 155 | 18.7 | 810 | 97.9 |
| 4 | 17 | 2.1 | 827 | 100.0 |

Question 15f: What do You think about tubes in work zones? Coded answer.

| TUBE | Frequency | Percent | Cumulative <br> Frequency | Cumulative <br> Percent |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 291 | 35.5 | 291 | 35.5 |
| 2 | 317 | 38.7 | 608 | 74.2 |
| 3 | 142 | 17.3 | 750 | 91.6 |
| 4 | 69 | 8.4 | 819 | 100.0 |

Question 15g: What do 耳ou think about impact atenuators in work zones? Coded answer.

| IMPATEN | Frequency | Percent | Cumulative <br> Frequency | Cumulative <br> Percent |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 505 | 61.4 | 505 | 61.4 |
| 2 | 193 | 23.5 | 698 | 84.8 |
| 3 | 66 | 8.0 | 764 | 92.8 |
| 4 | 59 | 7.2 | 823 | 100.0 |

Question 16a: What do you think about the height of arrow boards in work zones? Coded answer.

| ARBOHEI | Frequency | Percent | Cumulative <br> Frequency | Cumulative <br> Percent |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 126 | 15.2 | 126 | 15.2 |
| 2 | 39 | 4.7 | 165 | 19.9 |
| 3 | 628 | 75.6 | 793 | 95.4 |
| 4 | 38 | 4.6 | 831 | 100.0 |

Question 16b: What do you think about the brightness of arrow boards in work zones? Coded answer.

| ARBOBRIG | Frequency | Percent | Cumulative <br> Frequency | Cumulative <br> Percent |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 627 | 75.6 | 627 | 75.6 |
| 2 | 11 | 1.3 | 638 | 77.0 |
| 3 | 182 | 22.0 | 820 | 98.9 |

Question 17a: What do you think about the height of changeable message boards in work zones? Coded answer.

| CMBHEI | Frequency | Percent | Cumulative <br> Frequency | Cumulative <br> Percent |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 31 | 3.7 | 31 | 3.7 |
| 2 | 44 | 5.3. | 75 | 9.0 |
| 3 | 717 | 86.3 | 792 | 95.3 |
| 4 | 39 | 4.7 | 831 | 100.0 |

Question 17b: What do you think about the brightness of changeable message boards in work zones? Coded answer.

| CMBBRIG | Frequency | Percent | Cumulative <br> Frequency | Cumulative <br> Percent |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 150 | 18.2 | 150 | 18.2 |
| 2 | 54 | 6.5 | 204 | 24.7 |
| 3 | 599 | 72.6 | 803 | 97.3 |
| 4 | 22 | 2.7 | 825 | 100.0 |

Question 18: Are there any unclear or confusing signs in Illinois work zones? Coded Answer.

| CONFUNCL | Frequency | Percent | Cumulative <br> Frequency | Cumulative <br> Percent |
| ---: | :---: | :---: | :---: | :---: |
| 1 | 652 | 85.9 | 652 | 85.9 |
| 2 | 21 | 2.8 | 673 | 88.7 |
| 3 | 45 | 5.9 | 718 | 94.6 |
| 4 | 24 | 3.2 | 742 | 97.8 |
| 5 | 17 | 2.2 | 759 | 100.0 |

Question 19: Should we add any signs or messages to work zones? Coded answer.
Cumulative Cumulative
ADDSIGN Frequency Percent Frequency Percent

| 1 | 572 | 77.6 | 572 | 77.6 |
| ---: | ---: | ---: | ---: | ---: |
| 2 | 18 | 2.4 | 590 | 80.1 |
| 3 | 147 | 19.9 | 737 | 100.0 |

Frequency Missing $=97$

Question 20: Today, did you drive through a work zones in Illinois? Coded answer. Cumulative Cumulative
DVTODAY Frequency Percent Frequency Percent

| 1 | 774 | 93.5 | 774 | 93.5 |
| :--- | :---: | :---: | ---: | ---: |
| 2 | 53 | 6.4 | 827 | 99.9 |
| 3 | 1 | 0.1 | 828 | 100.0 |

Question 21: How can we make driving through work zones better for you? Coded answer.

| DRIVBET Frequency | Percent | Cumulative <br> Frequency | Cumulative <br> Percent |  |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 492 | 100.0 | 492 | 100.0 |

Question 22: Any other comments you would like to make? Coded answer. OTHCOMM Frequency Percent Frequency Cumulative Percent

| 1 | 252 | 100.0 | 252 |
| :--- | :--- | :--- | :--- |
|  | Frequency Missing $=582$ | 100.0 |  |

## Survey Question 18: Unclear Signs

Number
8 Not far enough warning on busy days.
19 Speed limit signs.
20 Sometimes a diff. speed sign.
29 Chicago area.
45 Flashing lights to bright (arrows).
52 All.
55 Occasionally "detours" are.
65 Lane closed-which one?
67 Lane closing milage not accurate.
69 Sometimes (2 lane road)
96 Should have signs saying merge(left or right). Now! So cars could get in proper lanes well in advance;
113 Ill. suck on work zones.
130 Right lane closed sign, left lane road closed.
147 Been on the tri-state lately?
184 Merge immediately, not last minute.
189 Sign says 1 MI- work zone $1 / 4$ mile
200 On 490 const. in Chicago.
205 Yes most of them.
218 Rt not
268 They change conditions and signs remain the same.
277 When to start slowing down.
279 Left lane closed - only right is closed.
281 Sometimes they tell you the right lane is closed and the left lane is closed.
302 Message boards don't always work (The message is sometimes missing or parts of the message is missing).
33045 mph when flashing.
345 Tri-state.
350 Speed limits.
351 Speed limit.
363 Need to notify driver of work zone ends.
409 Sometimes when right lane closed past off ramp you have sign out early and you don't know if right lane on off ramp.
422 Lane closing.
$424 \quad 45 \mathrm{mph}$ zone and no workers for $1-3$ miles.
441 Exits are not marked with big enough signs or far enough in advance in work zones.
443 End construction zone?
447 On I-294 through construction lane change areas where shoulders are used as lanes. Lane change faster than signs warning.
461 Message boards.
487 Exit ramps for dividing highways and highway designations.
488 Off ramps.

Be sure to take down when done.

Messages more.

Lane shifts and merges at toll booths.

Any type of hazards that are around the construction area.

Where exits are marked - through traffic is not.

Signs up before construction starts.
Right lane closed.
I think too many people are going too fast to read all of them clearly.
At nite.
Left lane closed when right lane closed.
Trucks stay in left lane.
Chicago, IL.
Changeable message boards.
Lane closures.
55 to 45 zones.
Sometimes no workers present.
Misleading "wrong" lane closure advertised.
Don't specify bridges being closed.
Chicago land area.
Two seasons in III., constr. and winter, work longer hours and get completed.
They say one lane is closed but the sign says the wrong one.
When road sign says right lane closed and the left lane was closed.
People just have to become more aware and courteous of other drivers and workers.
Speed limits (flashing or not).
45 when working people run 45 when nobody working.
Trucks left lane.
Speed sign? Old or const?
Not enough notice.
A sign with an arrow pointing to a left lane exit when the exit is to the right.
Sometimes width signs are too small to read at posted speed limit (signs before const. site).
Barrels and cones move or blow away.
Speed limit signs.
Truck only lanes change to many times.
Exit signs.

Does not state which lane is closed soon enough.
Don't see reason for some barriicades! Don't see work being done!
Do not see the reason for them.
They suck.
They don't always work.
Bump.
It says one lane and not which one.
Alternate 45 and 55 mph zones.
Trucks right lane, left lane no advance warning.
Speed limit.
Arrow boards.

395 Old signs taken down temporary signs put up that are not clear.
422 How far to const.
440 Mark exits plainer and more visible.
457 Looking for the off ramps in the middle of a zone.
461 Message boards.
469 They just say work zone, nothing else, not enough time.
470 Too many to list.
487 Exit ramps for dividing highways and highway designations.
490 Don't come to II that often.
502 IL puts up signs and then leaves them up long after the work is done.
546 Trucks stay in right lane.
581 Message changes too slow to read all.
592 Lane closures
602 Sometimes not marked clearly.
637 To slow.
64936 and 55 split doesn't make clear with bridge is closed, goes too fast, can't read.
653 Direction of travel.
691 No signs up when there are no construction.
694 Chgo land area.
784 Directional.
825 Sometimes a sign will say lane closed a distance ahead and then the next sign will say to get in that lane lane to turn or exit.
853 II. is in a state of confusion.
858 Sometimes they put up the wrong lane closed sign.
921 Flashes message too fast.

## Survey Question 19: Should We Add Any Signs Or Messages

## Number

5 Say how many miles it is.
10 All vehicles must reduce speed.
13 Miles or two close, should been a longer distance.
14 Signs before work zones move to one lane.
16 Farther back, a copple baoards at dent space.
27 Lane closure ahead, merge now or be ticketed.
28 To many driver don't read signs.
33 Length of construction.
45 Cars slow down too.
53 No passing sign included when lane closed ahead.
58 Flagmen has to be farther off construction zone.
65 1 per mile on length of work zone left to trailer in.
68 . Be alert for trucks trying to merge.
69 Cars like to pass trucks.
77 Digital sigas help.
83 Need to give more notice of work zones.
84 More advance warning.
88 More warning signs 3 miles ahead or so.

To tell cars that when lane is closed to get into the right lane.
When is next work zone.
Merge left/right now!
L lane, R lane closed ahead. No passing $1 / 2$ mile before the lane closure.
More advance of work zones ahead 3-5 miles.
Make distance more clear to ending of lane.
Merge now, cars yield to trucks.
Distance between cars and trucks.
Sooner.
More merging signs.
Smily face like Michigan.
Advise vehicles to merge further from zones.
"merge before last minute".
State which lane is closed further down road.
You might be more forceful on your merge signs as cars wait till last minute to merge and usually causes a bottleneck.
Put sign farther down road and be sure they are correct.
If it's backed up.
Specify if there are flagmen and working vehicles in the way.
Lane closed do not bottleneck.
Yes farther out.
More warning lights at night.
1-if workers are present or not. 2-the condition of the temporary road - uneven or narrow.
When a lane closure is ahead it should tell motorist to merge now! not at the last second.
No passing signs well before the lane closes.
Alternate routes.
Rush bridge crossings, shoulder drops, dips, grooved roads.
Miles before merge.
When to star slowing down.
Fines triple and loss of license.
Signs are too close and arrows are too bright.
Keep lights on dim to meet oncoming traffic.
Have a nice day.
The more distance before work zones is helpful.
Try fake police lights at night, they are really effective.
For cars to get over when its time before you get to the end.
Just be sure when they say left lane is closed it is not the right or the other way.
Warning signs and traffic backup signs should be well enough in advance so other route can be taken or considered.
Length of work zone.
More along left shoulder, more flashing message boards with quicker messages.
Give some warning at scales - (mile marker, etc).
Better warnings, length of construction area.
maintain 55 mph .
Specify the speed allowed.
Type of repair, bridge, pavement, etc.
A sign is needed to show a lane closure sooner than they are.

Let them know further in advance.
End work zone, resume normal travel.
More emphatic signs for workers on roadway in work zones.
Work zones that are active 1 speed limit, inactive ' 55 '.
What lane is closed when first construction sign goes up.
Lane closure sign earlier or farther from work area.
Length of construction.
More advance when lane is closed ahead.
Be harsh with cars lane closed ahead- get over now.
Merge early when there is a lane closure and enforce it.
Uneven pavement, narrow bridge, bump.
Little more advise warning.
Add signs for the big holes and bumps.
What is being done.
In lane closures have a law officer there to regulate the traffic (keep the four wheeler from crowding up to the lane closure).
More advanced warning to lane closures.
State lane closures earlier.
There are helicopters patrolling work zones. Obey traffic control signs. You may be cited after leaving work zone.
Too much on one road.
To all drivers of cars read merge signs.
Be specific where the off ramp opening is.
Maintain lane.
Merge with arrow.
Warning on shoulders or slop.
More advance warning.
Don't know.
Detours.
Going in work zones work zones should double the fine.
Just make the placement more accurate.
More width signs, uneven pavement signs.
Use changeable boards in all work areas and not arrows.
Automobiles should be more aware of traffic and zones.
Slow down.
More information is helpful.
Distance to work zone and traffic pattern changes.
How much farther til end of construction.
More message boards with clearer messages.
Special situation need more info.
More so before work zones so we don't have the problem of cars merging at the last minute.
More advance warning $n$ heavy traffic area.
What lane is closed ahead, how wide the lane traveled.
Put signs up to tell cars please do not cut 18 wheelers off.
Vehicles entering and leaving work zones today.
Zones are cluttered enough.
Depends on zone.

About how many miles construction is.
Bridge offsets.
2 or 3 miles ahead what lane.
No driving on shoulder.
Multiple lanes width restricted, no passing.
More commanding messages.
More warning ahead of time.
Better directions.
Better merge signs.
Merge now.
3-5 mile work zone ahead.
1 mile before zone - SLOW DOWN - MERGE NOW.
Some of the time.
Need to extend warning of which lane closed ahead.
Make stupid pay attention.
Move to open lane before construction.
Signs that say move over should mean for everyone to move over as soon as they see the sign instead of after construction begins.
More message boards.
What the line is for speeding through work zone.
Keep workers in their work zone.
Get people to merge over sooner.
Time and date.
Car it mean to you.
Cars merge now.
4 wheeler allow more space for trucks.
Radar patrol.
Let you know more in advance in some areas on where the construction is.
The actual height of bumps and dropoffs.
Both sides of road.
Tell the car to merge before the last arrow to avoid delays.
How much longer the work zone is. Ex- 2 miles, 3 miles, whatever.
More signs telling what lane is closed.
Many.
Specify what kind of conditions coming up.
Please allow trucks to get into proper lane - some construction requires truck to be held left lane.
Protect more to a flagman (maybe brighter signs to the worker).
Merge signs with law enforcement.
When you go to one lane there should be more warning 3-4 miles before.
When work is being performed.
Should be merged into the right travel lane before const.
In cities, a lot earlier warnings of mergings.
A lot o times you'll come up o a work zone too quick and not enough time to merge, signs should be further back.
That merging traffic must yield to the truck lane.
How many miles const. lasts.

## Survey Question 21: How Can We Make Driving Through W.Z. Better?

## Number

1 Your doing fine, thanks.
3 No drop off on pavement.
4 Don't make the lane too narrow in single lane route.
5 Their okay.
7 Widen and smooth out restricted traffic lanes.
8 Find a way for traffic to get into a single lane before they get to the site.
9 don't make lanes small trucks do not shrink. Flashing lights blind you as you go into work zone(just turn them at different angle not directly at you).
10 Make sure flaggers stand in the clear. Post flaggers farther back instead right at job sight.
14 Make it so const. truck don't slow car or trucks on roadway.
20 Wider lanes.
21 Be stricter on some of the laws.
22 Strict enforcement of speed limits.
23 Have less work zone.
25 Give a better warning. Have flaggers where you can see them, not right on top of the workers.
Sometimes you don't know if he is a worker or flagger.
28 Repair road while working on it.
29 Make sure people know in advance and tell the repeatedly that a lane is closed and to move into the open one ad STAY THERE.
At night some of the arrow signs are too bright.
Keep taking greater measures for safety.
Instruct all motorists thru message boards to maintain a constant-steady reasonable speed thru work zones.
37 Be able to merging traffic down to one lane better.
41 Make space wider, move them barrells over.
44 Have better enforcement of speed laws through them.
45 Get construction done quicker.
48 Take the edge lines out of detours.
49 Shorter work zones and over restricting lanes.
50 Shorter work zone areas.
51 Better looking flaggers.
52 You can't.
53
Speed up repair efforts, the longer the construction the more chance of a problem.
Complete stops are inconvenient.
More advance notice in cities.
Everyone including passengers cars when there is a lane closure and were to merge that everyone merges before the lane ends so traffic will run smooth.
Cars need to learn to merge at the proper time, not at the last minute.
See to it that when you have merge to one lane that cars do so and not at last minute.
Keep the workers in the work zone not in the driving lane.
Trucks have there own lane so cars can stop trying to pass in construction.
Do sections one at a time.
Speed up the construction. Danville area is a mess and has been for some time. Need better contractors.
69 Zone workers be more aware of traffic.

Shoulder better condition.
Teach four wheeler to read and understand the sign.
Get the highway fixed.
Let us run at 65 the same as cars in the state.
Give a little more driving width to lanes. Earlier warning of zones.
Lower speed.
Sometime work areas are too long. If long work area, put a 2 mi passing areas somewhere along the way, then fill those areas when the rest is finished.
Make speed limit signs more specific.
Give more space between traffic and workers.
More advance warning.
Make them a lot more even.
Just keep them 12' wide.
Not wasting space-sometimes too much space is taken from lanes where it seems little or no work is being done.
Make the advanced warning area longer.
If you're to work on a road work, don't just put signs and see construction being done.
Get these 4 wheelers to get into lane before they get to it. A lot of them will do anything to get ahead of you, like going into ditch to pass on shoulder, etc.
Repair roads 24 hrs a day and shorten construction times.
Signs/msgs should read what lane closure (st) well in advance. Msgs should be blunt and to the point.
Have motorist merge half mile before lane closures, this would stop the traffic tie ups if motorist would not try to get to front of line.
Make lanes wider.
Less work zones.
Don't like the speed old drivers go on road.
Make traffic flow as smooth as possible with minimal delays, slows, or stops.
Give trucks more room on both sides.
Fix the road the first time like they do in Georgia.
Don't do a 10 mile stretch at a time.
There's really no way to combine people close to moving traffic and make it safe.
Warn cars about them.
Patrol work area a little better and four wheels cause a lot of confusion in this area.
Road bed needs to be smooth with no joints where your steer tires run.
Traffic lane too rough.
Don't know any other way.
Have more police to give more tickets to autos and trucks going faster in work zones.
Make the lanes as wide as possible.
Do not block 10 miles for a 2 mile job.
More encouragement for cars to get into line and not stay in closed lane.
Most cars, auto mobiles do not read signs when approaching zones and then try to cut in.
Shoulder leans too much.
Get the work done faster and get out, too much standing around by workers.
By making it the law that all vehicles are to be un open lane before reaching a thousand feet.
Get rid of them.
Make the crossovers more even. Also curbs on bridges should not be there especially when you
have only one narrow lane.

Control the cars that merge in at last second and make the backups worse.
Get traffic to merge sooner.
Warn the driver sooner.
Smoothen out bumps before you do work in other lane.
Most people try to get to the front causing back up, and most of them are cars.
Just get it done.
Advance merging signs.
Nothing at this time.
By letting us know sooner.
Don't work in work zones in busy time of the day.
Get more educated flaggers.
Control speed into work zones on vehicles that seem to think they have to be first.
Make more room on bridges.
Make driving lanes wider.
Speed up work.
Make the lane we're driving in a better road.
Get it done.
Get the cars to slow down.
Make them smoother.
Take the lane arrow down, it's way too bright, your blind for a couple of seconds.
Don't make the lanes so narrow on one and two ways or lanes of traffic.
Change color of lighting on work signs(lighted)-yellow is too bright-blinding at night.
Make speed limit the same for both cars and trucks. Even if it is 55 it should be the same.
Make them shorter.
Do most of the construction in off peak hours.
Dim the arrows, especially at night.
When coming to one lane, traffic advise further back and be harder on cars who cut you off. Control speeding more.
Fix the road to be run a little better and the dropoff on the shoulder.
Somehow solve merging problem and signs to dim lights(off bright).
Merge before getting to lane closure, as there is always a tie up due to 4 wheelers crowding in the last minute.
Have flagmen stay off the centerline.
Maybe by informing us of bumps at bridges or rough spots, don't leave ridges on inside shoulders with dropsides. This tends to grab radial tires and pull you that way.
i.e. bridge repair-wider also asphalt sides thicker so there is no dropoff.

Some of the zones need more advance notice, and the flaggers really do need to stop walking in front of oncoming trucks. We cannot stop like a car.
Maybe not as long sometimes.
Turn down brightmess of arrows. Give better notice of lane closings.
Make people get out of closed lane in advance or give them a ticket.
Lower brightness of arrows at night.
Plenty of advance warning, dim those arrow boards a little. Driver can be blinded by those at night.
Lower the amount of distance between beginning and end.
Have state patrol more present during construction times to slow traffic down.

Keep lanes wider.
Give enough width for oversize trucks. You need some play with lane shifts.
Make the last 2 miles before lane closed a no passing zone.
Blue lighted signs and more advanced warnings.
By remember the width of a truck some work zone leave very little room.
Only barricade where work is being done! Not 5 miles before and 5 miles past.
Cut back on the amount of actual work zore needed.
Police control of work zones would help deter a lot of suicidal last minute lane changing and help control speed and traffic flow.
Fix the roads right the first time and be done with it. Don't half ass it this summer and then do it again next summer.
Keep barricades out of lane that is open.
Fix it right the first time you won't have to do it every year.
Enforce the speed limit (if one speeds the rest follow).
Enforce speed slow it down.
Sometimes cones and barrels are in travel lanes.
Better advance warning. Better merging single lanes usually too long. Why block off single lane for $4 / 5$ when only working in 1 mile.
Post HP officers in work zones ticket overcrowding when changing from 2 lane down to 1 lane. They pass on right shoulder then everybody wants to be first.
I feel you are doing what you can.
When its down to one lane, the lane that you use should be a little wider.
Quit tearing up the roads, leave them alone.
Give this test to some car drivers, they don't read signs.
Sometimes lanes are too narrow for trucks.
Smoother.
Not have so many of them in one area.
Make lanes wider and keep everyone going at the same speed.
Wider.
Ticket people who wait to cut in on lane closure and drive too slow.
To make the non-semi trucks (cars) to be more careful and to make decisions sooner.
Get the workers to stay in work zone, not in driving lane.
In some cases long range notice of work zones and delays would be helpful to allow a route change.
Widen through lanes.
Make work w/4 lanes and wide enough for three of me.
Take car and show them how to read signs.
Speed up the \#\% \$*! work, you people are lazy and work too \#\%\$*! slow.
Adavnce warning and speed limits.
Smoother roads, not these that tilt you sideways and twist back the other way.
Hiway patrol presence would help but anyone who wants to drive like an idiot is going to drive like one.
The workers could respect us and don't try to be smart and see how close they can get til we move.
Do something to slow cars down before lane closes, they try to beat the big truck to the lane's end.
Insure if concrete barriers are used, leave adequate space to allow 2 full lanes or cut down to
one lane.

You can't.
If I could tell a difference after they were done.
Make lanes wider.
Widen roadway for lanes.
Make signs more clear about warnings dim one lane arrows.
Come down on speeder a lot harder.
One is by having the workers stay behind the barriers instead of standing in or too close to open lane.
Not during rush. Put a cop where you merge to stop people from cutting in front of you.
Chance from the amber arrows to the violet colored ones.
Try to have less of them.
More advanced warning.
They're alright except around Chicago is really bad.
When going to one lane find a way to stop cars from flying up in closed lane and at last second cut you off.
Widen the lanes by using smaller markers and not as many, too manyfor long distances plays tricks on your eyes. You can't tell where the lanes are.
Speed limit.
No way.
Give trucks more room, we are a little wider than 4 wheelers.
Close off what they are working on, not 20 miles extra.
By not being so tight on the one open lane.
There's not much that can be done except to maybe clean usable lanes better such as rocks and debris.
Remember that the 40 ton truck I'm driving needs room to manuever.
Do not charge truckers so much.
People just wait too long to get over.
They're okay part of the time.
The only real problem I have with construction zones are the flashing arrow boards at night. They are the same height as my windshield. When my windows are dirty or its raining.
More road signs along left shoulder as well as wider shoulder widths - especially left lanes.
Brighten up areas.
Watch lane width for big trucks.
Keep workers out of driving lanes - open.
Make the lane that is open in excellent shape before motorist drive on it.
Make them as wide as possible for wide loads.
More law enforcement entering work zones.
Put dimmer lights in.
Please don't run us on the shoulder, it is uneven and sometimes hard to control the truck or trailer.
Work during early morning hours.
Wider lanes.
Put the cones where necessary and make sure the workers stay behind the cones.
No yellow long lines of lights.
Allow enough space for large vehicles to make necessary manuevers.
Keep barricades out of lane - sometimes they encroach on my lane.

Some places need to be wider. Uneven pavement is dangerous (rocks the trailer). The flagger needs to stand further back (off the line).
Keep workers out of road (thru lane).
Hurry up and finish.
I don't like speeding private cars.
No passing on right shoulder.
Tell workers not to stand on concrete barriers while traffic is passing by.
Specify work zones in an area not all along the interstates from Missouri to Bloomington. Most areas I seen weren't even being worked on like they started somewhere else before finishing.
Enforce the lane closures by making sure cars don't run up to the blockade and then try to force other vehicles to stop in order for them to change lanes.
I think you're doing okay for the most part of work condition today.
Crossover lanes in median longer to straighten out turns, make side to side transition safer.
Better drivers training programs.
Arrow board too bright or change angle.
Too bright, too low.
Get cars to merge earlier not at the last second. Have police at advanced warning area.
Shorten zones to just what is worked on.
Block off road area that is being worked on, not five miles for a five hundred foot section.
More advance notice of lane closings.
Squeeze lane so all would not jam up.
Somehow filter traffic from 2 lane to 1 lane in advance of actual work area.
Wider traffic lanes.
Get work done, quit screwing around.
Give more room in lanes.
Mark which lane closed farther back.
Have cops ticket people that do not obey lane usage like shoulders and trying to run to the last foot before moving.
Work faster.
To have the speed be the same in a work zone (if part is 45 mph then make the whole zone 45 mph).
Don't block off 10 miles of roadway to work on 50 feet at a time.
Give fair advance notice.
Try to keep traffic slow.
We need more room.
Keep the workers away from the barrells on our side of the road.
Keep lanes wide emough so a semi may pass by safely. Example-don't set cones so close that it is necessary to get very close to concrete barriers.
410 Educate people to get out of lane closures early to prevent back-up. 4 wheelers pass everyone in that lane and have to get over the last minute and slow or stop open lane traffic.
*When traffic is heavy and there is a lane closure merge early to prevent jams at closure. Dim the warning arroes at night. It is like looking straight into 7 headlights on hi beam.
Fix roads.
Begin roads right to start with.
Longer warnings.
Widen, better directions, give four wheelers tickets for flying around to get ahead or going right to barricades and forcing their way in.

Most of the work zones are very narrow for tractor trailers in addition to having uneven pavements while traveling thru the zones.
Make the converging of two lanes longer and gradual.
Make work zone areas shorter, in length (miles).
Make zone shorter-can't repair only so much at a time, don't need to mark off miles at a time. Some of the work lights shine right in your eyes! They should fix them- to shine away from oncoming traffic.
Lights.
Fix the road right the first time.
Fix em right good for 5 years.
Try to smooth out the driving lane.
You are doing a fine job.
I don't know how, but I believe it must be difficult to fix roads without closing roads.
Better traffic flow and wider lanes.
Get the work completed - stop playing around.
In lane closures have state police direct traffic to stop crowding in at last minute.
Flagmen need to back up a little, they are too close to oncoming traffic, and often not seen until the last moment.
Workers need to fix the roads to where they are smooth yield signs for oncoming traffic merging. Getting the work done quicker.
One hazard is oncoming traffic in two way, with bright lights hard to see road surface. Mainly always warn of their location at least 3 miles ahead of time.
Assign more police units in these areas. Then support them whole heartedly while they follow their directives all the way through the court room.
Sign to tell drivers to keep speed up to at least the speed limit.
Don't work until night because of less traffic. Do only what they can get done before daylight hours. Not 10 miles at a time.
Do construction work at night possibly? Not at rush hour! Speed should be 55 mph to keep overcrowded one lane only passage as free as possible.
Do the work faster.
The last two days work zones were fine. Speed limit were at a safe speed.
Tell the construction workers to be more aware of where they are standing in relation to the moving traffic.
Move merge signs closer to work zones so merge must be done quickly and smoothly w/out speed reduction.
More warning. Slow speeds down.
More warnings and less shoulder dropoffs.
Wider driving area.
Keep workers away from lane of traffic, they stand there like they want you to hit them.
Keep cars in line, not going to end and cutting back in. They do not know how to drive.
Keep available lanes as wide as possible - the use of cones should be more uniform in respect to lane width.
Crossover weather its slope or going into opposite side direction.
ill. roads are one of the worst states for highway repair.
Put warning signs further away from work zones.
Stop making bump out of good road.
Finish your job.

Slow cars down.
Wide the lanes better than they are.
Not so many at a time.
Make them wider.
Bypass lanes wider - workers more aware of danger from being struck - work lights at night should not be directed to oncoming traffic.
I hate dropoffs.
Same lane closures with concrete barricades are too close for trucks especially around curves.
Kept width area the same. Don't narrow down at the last moment.
Do work right to start with.
Do work right first time and at quick reasonable time , quit stretching out for years.
Educate construction workers.
Teach 4 wheelers what a construction zone is.
Better lanes to drive through.
Maybe by not leaving quite so many sharp high edges of starting and completing of surface.
Any state that outlaws CB radios in commercial vehicles shouldn't be allowed in the United States of America.
Educate drivers to form a single sooner.
Put barriers on inside of lane being worked on. Wider lanes - do one section at a time and finish.
Sometimes lane work is too narrow, bridge work has bad dropoff.
Have the worker work at night not daytime.
Arrow boards brightness at night affects vision and ability to see. I have not experienced this in III.
I really don't think there is a whole lot that can be done outside of the speed limits, but that doesn't apply to all zones either.
Fix the roads better.
Make people slow down.
Do more construction at night when traffic is light.
Give tickets to cars that speed up and try to pass before work zones.
More warning in some cases!
(Wider lanes).
Maintain constant speed 55 mph .
Get the cars off the road.
Make alt. routes smooth and even.
Don't shut 3 lane rd down to 1 lane, leave 2 open.
Crossing over to other lanes would prevent us from having to keep a careful eye on workers walking in front of us.
Finish the roads, it's been long enough.
Make sure the workers stay on their side of the barriers.
No median crossover during winter months, too dangerous.
Lower shut down lane to approach of work zone.
Open roadways that are not being worked on if possible.
Wider lanes.
How many miles is the work zone. How long will construction last, open shoulders for 2 lanes. W/O median crossovers and cement barricade.
Have construction cones and barrels in proper place.
Get the work finished.

561 Educate automobile drivers: To merge into "thru" lane earlier, instead of waiting until the last minute.
Make lanes a little wider on iverpasses and bridges, eliminate rough bumps in said areas.
When zone is identified and lane closure occurs. Devise a way to have traffic merge before the last minute thus cutting down on traffic jams.
Work at night when there's less traffic.
Shorten the length of work zone. Hire new work contractor for Danville.
Build the roads good the first time - other states can do it.
Make pavement more even on edges. Keep barrels back for room. Have someone checking for blown tires in roadway.

Make their taper aprons off and on of area of pavemnet or bridge being worked on.
Need more police to enforce traffic.
Get rid of unnecessary construction.
Somehow try to merge 3 or 2 lanes of traffic into one. On a weekend traffic has a hard time doing this.
Make lanes wider.
External warning zone, use blue message and arrow signs.
Tell your workers quit walking out into the traffic lane - they act like we have to stop - some of them are very careless.
More time to know what lane is closed.
Keep men, barriers, equipment, OUT of open lane. Try to keep lane width on bridges at least 12'.
Use of more crossovers - would help the safety of the workers.
If you could weight down the orange cones so they don't blow away are in the road.
Ticket drivers passing in work zones.
More advance warning about lane closures would help. The more traffic the more warning.
Make merging lanes more meaningful.
Make sure your construction crews are far enough away from the traveled part of the road, most are standing right in your way.
Slow traffic in work zones would help.
Work at low traffic times.
Unless there is a partial car in the work zone cars and some trucks drive too fast.
More advanced warning.
Shoot 4 wheelers that do not allow others to merge.
Try to find a way to get cars to merge before the last minute.
Trucks are wider than cars, $9^{\prime}$ is not enough.
Have the cars to stay in the right lane that is open.
Teach cars to comply with work zone rules.
Keep the cone back out of the drive way.
Tell const. worker to stay on inside lane. They will walk out in front of you just as if they are daring you to hit them. A lot of that goes on.
Keep the cops in the work zones - radar slows most maniacs.
Less work zones.
Less work zones.
Ill. is one of the best states to run through in const. zones. They give plenty of warning signs ahead of zones.
By warning of which lane is close sooner. By putting sign higher or on a changeable message
board.
628 Bypass for cars.
629 Make people in cars drive faster than 40 miles an hour.

Close only the portion of the road that is being worked on. Keep workers out of lane of traffic.
Give lane closer 20 miles to advance.
Don't have 10 miles of cones or barricades to work on 20 ft of highway.
Need more advance of work zone.
Slow the traffic, divide with concrete.
Make lanes wider.
Put flagmen in more visible spot and merge sooner to cut traffic jams.
Do more work at night when less traffic, need to taper traffic further back so as not to bottleneck.
Taper the lanes down more, so cars can't bottleneck.
Don't let 4 wheelers cut around on shoulders to get by truck.
Some work zones are way too long.
Keep workers inside barricades.
Arrow sign boards need to be dimmer and not aimed right into a drivers eyes.
Less of them.
Make sure the four wheelers form a single lane before arrow.
It's ok now like it is.
Stop cars from racing to construction areas.
Dim light arrows at night (too bright).
45 mph speed limit.
Have the workers stay inside of the designated work area. It seems they like to play chicken with you, not only trucks, but cars as well.
Center lines and edge lines should be much more visible!! (and even on roads not under construction)
Give us more road surface to run on. When we have to drop off on median we take a chance of load shift.
Work on one side of the freeway at a time.
Only close lanes where work is being done. Not for 10 to 12 miles.
In my opinion there isn't much way.
Get 4 wheelers not to wait merge at end their lanes and crowd in.
Make lanes open when not working on them.
Do them at night when there is less traffic.
I feel that the flashing error should remain constant and not flash.
Get the roads repaired and finished so you won't need to have them for so many miles.
Wider lanes between barriers.
Keep lanes wide enough.
More clear signs, more courteous and professional workers.
Fix it right the first time so we don't have so much construction.
If you have to drive on shoulder make sure shoulder is in decent shape.
Work roads at night.
Wider lanes, earlier warning on merging, better driver awareness for four wheelers.
Wider lanes, earlier warnings, teach Illinois drivers to merge before they get to the barrier.
Ticket people that runs by all other traffic when they have already merged.
Wider pavement if possible.

Make arrow light less bright.
Work longer hour and them done.
Should have a highway patrol at advanced warning area.
More control of vehicle trying to cut off at merge - control vehicle passing on shoulders in merge areas.
Don't work during rush hours in big cities. Don't start construction (bridge) in late fall.
Law enforcement.
Place police in every work zone possible, too slow traffic to posted speeds, and put an end to last second cut off.

By having more police in work zones, to enforce the speed laws and control the traffic movements.
Make the work not so long.
Make it a law stating that all cars and trucks should have to move over as soon as they see the signs. Shorter work areas, work faster to finish the area.
More message boards.
Somehow keep the cars from waiting til the last minute to get in the correct lane without causing traffic jams.
Educate the people about the dangers of trying to pass trucks too close to work zone where road goes to one lane.
Get cars to get in lane that is open sooner. They go around truck in work zone.
Get law enforcement to ticket people who speed to the front of a merge lane and then cut over at the last second.
Wider lanes.
Merge trucks before cars.
Get cars to merge into one lane prior to getting to construction.
Fix shoulders better.

1. Cover signs when not in use. 2. Don't leave 45 mph lights on when there are no workers around.
Get four wheelers off the road.
Finish them quicker.
I personally feel that they're satisfactory.
Let us know before we get there.
Educate workers a little better about staying in the work area, not wandering out into the open lane without looking.
They seem okay to me.
Police need to enforce four wheeler.
If lanes are not being worked in, remove the barricade.
Make lanes more even because they often have dips or chuckholes in them.
No cops.
Better lanes to drive in, no holes or dips.
Limit to 2 or 3 miles at a time.
Make lane $x$ overs wide and flat not sharp comers. Soften lighted arrows at nite - they tend to blind.
I think you're trying. Its the cars that have to read the signs.
Work zone ok, raise speed to match cars on open road, leave our CB alone.
Make transition lane wider and don't have them so close to workers.
Quit raking so much of the highway that's not being worked on.

Station police at work zones - especially at peak driving hours.
Leave a police car at beginning or before with radar on so people don't try to go like hell before cutoff starts.
Truck lanes.
Leave wider lanes.
More night work when traffic is less.
Get the traffic to merge sooner before you get to the constr. area. Police should patrol more by stopping motorist from driving up to const. that is blocked off.
Make lanes wider, post police.
The workers should also watch out more. They take a lot of chances and will step out in front of you. They leave too little room.
Try to arrange the work so it doesn't almost shut down a major artery such as 294 and 94.
Do the job right the first time.
Start work before roads get so bad.
Don't be working on the road when I come through, or just the side I'm on.
The lighted arrow boards are fine in the daytime but way too bright at night, it makes it hard to see the road with a bright light in your eyes.
More warning - smooth median crossover - make them more wide and less curved, more room for trucks.
You can allow 2 lanes of traffic at entrances.
Advanced warning.
Make sure the lanes are wide enough for $102^{\prime \prime}$ trucks.
Give trucks wider lanes.
Keep as much width as possible. It seems most const. zones are made for four wheelers.
Slow the traffic down - have police help where traffic merges.

* More traffic control and improved merging practices.

Do all work at night.
By keeping work zones confined to the opposite side of the road from traffic.
Keep cars from running up the side of the road to get ahead of everyone.
Do not ban the CB radio, its use as a safety device in construction areas and highways is far more important than any reason for banning them.
To get drivers to merge when they should. That's what causes wrecks and confusion.
More lead time for lane closures (3-5 miles).
Merge traffic sooner.
Give more room for men and machines to clear traffic.
Use of in ground reflecrors, not blinding like barrels, much more clear to follow.
Block off only that portion that is being worked on. Example - don't block off traffic for 5 mi . for a half mile work zone.
More side clearance.
Advance notice of lane closure.
Shorten time of work.
Close the spot where you are working NOT a 10 mile length.
Once into the work area doesn't seem to be near the problem as - getting into the work area.
I think you are doing fine. But the traffic is going too fast where workers are. Allowing us to keep using our CB's.
Better traffic control if traffic gets all backed up during busy times of the day. Wider smoother lanes.

894 Tone down brightness of arrows at night, paint fog line for night drivers when construction is finish or halted take down signs.
896 Its ridiculous to have several miles of work zone in one given time. At best, should be one mile limit until completed. Then go on to next one mile.
898 Build a road that doesn't need patching every 6 mos.

914 Educate drivers of smaller vehicles what they should and should not do when approaching work zone in order for traffic to move safely and quickly.
916 Eliminate shoulder dropoffs.
917 Keep lanes wide enough for trucks to make it through safely.
Get the job done and get road open back up.

Do something with flashing arrows.
One of the biggest problems with construction zones are cars racing to get around trucks at the very point of lane closings.

Just notify sooner.
Repair the road right the first time. Skip the darn roadworkers job security.
In major metro. area like Chicago, you should leave one rte free of construction. They have the Kennedy; the Tri-state; the east-west; and the Ryan all torn up at the same time.
Make sure everyone drives speed limit - and stop cars from racing up to one lane zone before moving over and cutting trucks off because we are moving too slow.
Speed trap by them all.
Less zones.
Enforce the 45 mph .

## Survey Question 22 : Additional Comments

## Number

Radar detector law is unconstitutional when restricted to commercial drivers only thereby discriminating against 1 class of people.
8 Why do they always mess up the best side of the road first.
9 When moving barrels don't put them 2' in my lane, it's small enough.
10 Keep fixing the roads for better driving.
22 Should be like eastern states where the fine for speeding is doubled in work zones.
It seems too take too long to completed road const.
Keep fixing the roads, they're the worst we drive on.
Cars think construction zones are race tracks, raceing to get in front of trucks because trucks observe speed limits.
49 Teach auto drivers to stay in line, stop jumping traffic.
50
Educate the general public as to the hazards of cutting in front of trucks.
Tear roads out completely and start over like Iowa does.
If cars would get into the proper lane when speeding there wouldn't be any delays, instead they will pass then cut in at the last minute.
Secondary roads are close to getting OK. I-80 needs attention now.
Make sure this survey is used properly.
The cause of backups is people being in too big of a hurry and not thinking ahead making their move to single lane smooth.

131 To make it manditory for people over the age of 65 to take a driving test every 2 yrs. Some should not be on the road.
${ }^{\circ} 149$ Raise the speed limit for trucks in this state; make the laws the same for car as for trucks when apply.
152 Ill. roads are very bad and people working work zones are not careful. State trucks are the worst.
Keep open lanes in const. zones free of debris.
I think they should educate 4 -wheelers better on what it takes to stop 80,000\# and stop this cutting off trucks. We don't want accident anu more than they do.
There's no need to do so much construction at the same time, do shorter stretches.

175 Fix the road before tearing more up.

Raise the speed limit for commercial trucks.
Raise the speed limit to at least 60 for trucks, 55 is a hazard.
Raise the speed limit on open roads and around construction and towns crack down on cars and trucks if they speed.
Work zones should not take so long to repair, you go for months and no visual improvement. Flashing arrows way too bright-blinds you momentarily.
Make sure flaggers know what the speed limit is that you have posted. A lot of times I'll be doing 25 in a 25 and flaggers wave frantically to slow down for no apparent reason.
Repair the road instead of patching every year I-74 thru Danville.
Some cement barriers are held together withchannel iron and bolts. These tear up the side of tires causing blowouts in lane shifts, usually occurs during close maneuvering.
Police should patrol construction areas more. Mostly the last couple of miles before construction areas. Control bottle necking.
Hire flaggers with some common sense.
II. roads are in poor shape full of holes, when they repair holes, they turn from holes to bumps. Lower brightness of sign, blind us.
Work zone too long too much road take up at a time, makes poor traffic conditions (workers need to work harder).
With advance warning and a law enforcement person to stop shoulder rider. Work zone will be that much more safe.
Speed limit should be 65 mph for everyone.
Median crossovers are consderably safer than lane closures for the work crews, and these people should be protected while trying to do their job.
Roadwork in Illinois is very badly needed. They are one of the highest taxed states on trucks and I would rate them in the bottom 5 as far as the condition of the roads.
Raise your state speed limit for trucks.
Speed limit raised to 65.
Have too many cars poking around, slows everyone up and causes an accident.
Too many interstates around Chicago under construction at once.
The biggest problem I have experienced in const. zones is cars trying to beat trucks - usually on the right hand side - in both transition and termination areas of the work zones.
All my years of experience, I know what I'm doing, it is other people that scare me.
Speed limit is too slow, needs to be 70 for trucks.
Yes, your roads suck, the air stinks, food is lousy, and the tolls suck.
1 - The temp roads need to be wider too. 2 - I see way too many construction areas with lane closures, yet no work is being done - sometimes days or weeks.
If the workers paid fines for dangerous actions like we drivers do maybe things would be safer.
Tell other people working in zones to be more careful about steppingout into traffic lane before they "look".
Generally think when exit is "left" should say so on all interstates. I believe that by far the biggest cause of accidents in all situations is caused by following too closely, esp. trucks tailgating.
Don't tear it up if you're not going to fix it.
Keep cars at 55 instead of 65.
Cops need to ticket cars as well as trucks in merging zones.
1 st time loss of license 60 days, $2 \mathrm{nd}-1 \mathrm{yr}$, 3rd-life. Then people will slow down to protect workers.

The speed limit in this state is not right for truckers, truckers pay more h-way usage taxes than cars pay, but still trucks only get to do 55 , the speed limit should be the same for all, not just cars.

281
283

Do the construction at nite between the hours of midnight and 7 am .
The split speed limit is the most dangerous thing in the state ( 65 cars, 55 trucks). Should have alternate routes marked out better in Chicago.
Higher speed limit for trucks.
Put the walls high enough to block oncoming headlights completely.
Faster speed limit.
The concrete bars are usually too close for good driving.
Don't have so many on the same road at one time. It seems like every 5 to 10 miles there is one.
Too many times its hard to change lanes by cars trying to pass before.
Raise the speed limit for trucks, enforce slow speeds in work zones.
I think Illinois is one of the most prejudiced states for trucks.
It should be against the law to merge at the last minute in a construction zone. That is where I see the most accidents. Signs should be put up saying so and at peak traffic hours it should be strictly enforced.

* Too many cars overtaking trucks, keep CB radios, tell how long work zone is and plenty of warning signs.
Get the roads fixed as soon as possible. Construction slows us drivers down. (Money is time!). In narrow bridge crossing, repair the shoulder and patch the pot holes and make grade correct. Illinois speeds limits for trucks is reduced not mentioning the road fuel tax plus the DOT and the troopers are a bumch of *^\$\#*\%.
Enforce cars to merge while safe, instead of racing to work zone and cutting in at the last minute.
Don't make lanes so narrow.
A law should be made: headlights on whenraining.
You should seriously consider repairing roads correctly instead of patching problem with asphalt! It is never packed right so the hole dip or rough spot is still there.
Better specs. in building materials so roads are not in constant repair.
Teach people in cars that driving is a full time job. Teach people who drive cars more about trucks.
Workers need to be more aware of traffic and not step out in front of oncoming traffic.
Why 55 for trucks and 65 for cars. National Safety Council Study states: This causes accidents not prevents them. *Too many restrictions.
We don't need anything that increases the cost of operating trucks.
Don't use rolling patch crews. Patch a section and move on.
The workers try to stay too close to the road. Sometimes they act like they dare you to go close to them.
Driver need to slow down.
The 55 mph speed limit is a crock. Car can drive 65 and trucks 55 its unfair and discrimination. Plus the radar law is a joke, cars can have them commercial vehicles cannot.
*The exit of the scale the state boys fix on I-80 at Joliet is worse than it was before they worked on it. Why don't they take radar out of cars instead of big trucks, we are trying to make a living.
Raise speed limit up to other states 60 or 65 mph .

440 When starting project finish it before starting another one - don't mark work zones and nothing is there.

Enforce speed laws and tailgating law.
I think this is a good idea, because we need to make America's highways safer.
Construction projects like those which are needed on I-94 and I-294 should never be done at the same time and good alternatives to which this time have been good - need back up alternatives. When road grinding when come to bridge, put more cold patch in until they are ready to lay new asphalt.
I don't think it matters what you do, you can't help construction zones because there will always be someone to try to beat you into single lane or try to go through at 80 mph . And that slows all down.
Plenty of warning indicators to say what's ahead. Some people need them more than others so its good.
In the questions concerning signs and message boards, you can't have pat answers because whomever puts up signs or checks the bulbs may be remiss in their job, negating any of the answers I gave you.
Merge signs placed toos soon cars can hurry to raech front of line and cause extreme.
When there is no work zone there should be at all times 60 mph speed limits. Radar detectors (legal).
Advance notice adjust lighting, how bad crossover is.
Fix road right.
Do a survey on CB's. They are very helpful. If they are going to ban CBs they should ban the cellular phone.
Why regulated speed zones when driving a truck 55 you go to merge for traffic merging onto the Interstate at 55, you are now a driving hazard for cars doing 65!
Up the speed limit.
Make works and supervisors/engineers more aware of difficulty in manuevering large trucks through narrow restricting lanes.
Raise the speed limits for trucks to 65.
Kept workers in the work areas not in traffic area, including flag people.
There's 2 seasons, construction and winter.
On weekends or holidays open lanes that are not under construction to help move traffic.
Stupid new law on radios, because they are also used for a lot of good reasons.
Under the circumstances the crews have to work under, no, I think they are doing a pretty good job.
55 mph is too slow.
Up speed limit on open roads to $60-65 \mathrm{mph}$ for trucks.
Speed limit in Il. should be 65 for trucks.
Flashing arrows are almost blinding at night, dim them a little.
II. is one of the better systems to drive through. I'm glad to see some work is being done to improve the roads.
Don't take away our CB radios. It would be extremely dangerous inwork areas.
Barrels are sometimes too close.
Start construction at midnight, end construction at noon.
Not enough law enforcement in these work areas.
Make a decision on what lane they want to close and not a periodic change over.
IL. has some of the worst roads in the nation. Is this my tax paying dollars at work? Ask the

Europeans how to build roads, theirs last!!
Higher quality work.

Ill. can't build a smooth road - on smooth ground.
Don't put signs up saying bump ahead and leave them for six years like on I-74 on west in, those bumps are dangerous.
Match up crossover with lane heights to avoid uneven sway when crossing them.
People who drive cars should give truck more room. All they do is try to get ahead of you.
Raise truck awareness to young drivers in high school during courses.
Bring your speed limit up to match other traffic and reduce the harssment by state troopers.
A terrible hazard I have noticed (esp in Indiana) is a concrete or asphalt barrell bet. oncoming lanes in a const. zone which is not preceded by a line of cones or barrels before it commences to give you time to move over.
The arrow boards are way too bright nationwide.
There should be more police at work zone so the car won't cut off the rigs, cars running down shoulder and ditches to get to front of line.
Illinois like all other states is doing its best to keep truck traffic flowing as safely as possible I appreciate that.
Have officer whenever possible at point of transition.
Speed of cars and trucks should be the same to promote safer merging in work zones and all other times no matter what the speed 55/60/65 just so its the same.
Needs two officers at traffic jams to stop car from jumping in and out of lanes, pull them over and write a ticket.
*The BRIGHT arrows are right height to shine in truck driver's eyes. Sometimes the shoulder is too soft in a crossover situation causing danger of turnover.
14 Early morning - after driving all night, my mind is a little burnt - have gone through $1 / 2$ of work zone at 65 before realizing I was in it. Advise workers - early morning 7-9 AM - to duck.
How come they can put a man on the moon but can't make a smooth hi way!
They put up 10 miles of barrels work on 1 mile stretch.
Takes too long.
The worst part to me is cars speeding up to get 100 ft ahead of where they would be anyway.
Fix Illinois roads.
Few times I saw a police car facing traffic with its lights on before construction zones. It works!
Get rid of the split speed limit they are confusing for many people in cars. They cause traffic backups, they make people mad. They cause accidents.
With increase in revenue from C-D-L it's nice to see some improvements being made to roadways.
Signs that check your speed make you more aware of how fast you are driving.
State should stop cars from passing on shoulder.
Troopers should stop cars from passing within $1 / 2$ mile of lane closure.
Workers think they can just walk out in traffic and you are to get out in traffic and you are to get out of their way.
Above is the worst hazard in the work zone.
Flag people need to move out toward oncoming traffic.
Don't shut down one lane 2 to 10 miles before you get to anyone working.
In some areas I think they take too long to do the job.
Repeal the law against CB's in commercial vehicles. Truckers try to help the police with drunk drivers. Raise the speed limit for trucks.

Make the speed limit the same for everyone. Give back the right to use radar detectors or take them out of cars also, let's be fair.
6 Same speed limit for all vehicles excluding wide loads and overweights or permit loads.
Same speed limit for all vehicles.
There always seems to be at least one barrel or barricade in the driving lane.
Lower arrow boards.
Have a time and get them completed on time.
Too many vehicles think they should be first because they're in a hurry.
Give radar deectors back and change speed limit 55 or 65 for all.
Make it where the work areas get finish faster and in some places they could give you a little more room.
God help us.
Use top of the line materials, so you don't have to repair so often.
Illinois does a better job than the other states II drive through. (IND - MO).
Contractor need better (smoother) patches at joint repairs and approaches on and off bridges. They seem too be rough excessively in illinbis than most other states in the weather region.
As in any driving situation, conditions of the area determine my actions through the area. Don't take out our CB's. Come back with radar detectors.
I live in KY, TX, MS, GA, VA, and LA in the past 35 years. Since the states have changed the speed to 65 on rural areas their has not been any raise in percentages on accidents except for construction zones.
Arrows can be blindingly bright, in all states not just II.
Cars will make a squeeze play to get in front of you. Why is it that buses can travel 65 mph with a load of people and truck can only run 55.
It is getting like a communist state.
Raise speed limit for trucks to 65 mph , it is safer. Leave the Cb's alone. Lower fuel prices.

* The people that cut in at the very last second or run the shoulder to cut in.

Over all doing a good job. Its just people not paying attention or in a hurry or campers not knowing where they are going.
Need more roads repaired.
The workers should stay out of the travel lane of traffic.
Driving is not a problem as long as you pay attention to traffic i.e. people who don't use the interstate system regularly - RV's - old folks.
Hope all is finishe before it snows.
Would like for the work to get done faster.
Don't wait til it so bad!
If CB radio's are outlawed I will never buy anything in Illinois again.
Should 65 for trucks and 55 for cars.
Make more for trucks.
Lighten up the arrows, allow more width to lanes.
Number 1 complaint - electric arrows too bright at night.
Don't tear up all the roads at one time.
Too many to mention.
Why not finish one road before you take up the secondary road to go around the construction. No split speed limit on cars and trucks. Legal use of radar detectors and legal use of CB radios. Relay message to construction workers to quit challenging 80,000 trucks with their bodies.
Height of bridges especially in Chicago are not correct.

869 In rain or fog conditions make adjustments, with makers to many bright reflectors causes extreme blinding effect.
871 Need cooperation of small cars.
877 Flagging stand too close to merging lane.
885 Law enforcement is the only way to keep both cars and trucks from trying to be the FIRST in line.
886 Make it slow where workers are working.
889 Yes, when is 155 and 57 through Chicago going to be repaired.
892 Don't start work on roads in winter time.
Work on one area at a time - finish and then move on. Too much destruction not enough construction.
My biggest complaint is too long of work zone (at any one time they tie up traffic and compounding the presence of accidents).
Illinois speed limits stink.
When the cons. work is done all signs should be taken down right away. Sometimes they stay up for months and this causes confusion for months and this causes confusion for some travelers. They jam on their brakes and change lanes thinking the lane will close.
901 My CB radio has help in work zones. Talking to other drivers warn way in advance about backup in work zone.
902 It would make it better if everyone would merge to one lane instead of waiting until the last minute.
913 We need to educate people about sharing the road with eachother.
916 Construction seems to take a long time, finish one project before beginning another, especially in the Chicago area.
917 They should make the arrow boards intensify less at night because the last 200 feet aiming into the lane opening hazardous cause you get blinded for a second or two.
925 My only complaint is the cars that try to beat you to the lane closures. They are the biggest cause of accidents and traffic delays.
926 Try to make your one lane roads a litte wider in work zones - remeber these trucks are much too wide and therefore need more room than cars.

## APPENDIX D. Actual Values for Significance Level

APPENDIX D. Actual Values for Significance Level
Results of F-test ( $\mathrm{Q} .1,2 \mathrm{~A}, 2 \mathrm{~B}$ and 3 vs. all others)

|  | 0.1 | Q.2A | 0.2B | 0.3 |
| :---: | :---: | :---: | :---: | :---: |
| 4 a | . 0001 | . 0001 | . 0001 | . 0001 |
| 4 b | . 8565 | . 0850 | . 0110 | . 8537 |
| 5 | . 9540 | . 0001 | . 0007 | . 2179 |
| 6 | . 8386 | . 2294 | . 8457 | . 8734 |
| 7 | . 0032 | . 7339 | . 3293 | . 0001 |
| 8 | . 0365 | . 5494 | . 4079 | . 1634 |
| 9 | . 0482 | . 0189 | . 1046 | . 0815 |
| 10A | . 3819 | . 0182 | . 4440 | . 0092 |
| 108 | . 0038 | . 0001 | . 0978 | . 3248 |
| 10 C | . 0054 | . 0004 | . 7067 | . 57779 |
| 100 | . 0203 | . 1061 | . 3353 | . 2739 |
| 10E | . 0010 | .3195 | . 4684 | . 0018 |
| 10F | . 1789 | . 0005 | . 2551 | . 0036 |
| 10G | . 0778 | . 0844 | . 5250 | . 1697 |
| 10H | . 0292 | . 1817 | . 1992 | . 8172 |
| 101 | . 6035 | . 6570 | . 1470 | . 0499 |
| 11a | . 0047 | . 0751 | . 0432 | . 0014 |
| 11b | . 0001 | . 0418 | . 0217 | . 0001 |
| 12 | .3230 | . 1286 | . 5338 | . 2312 |
| 13 | . 6400 | . 8545 | . 0248 | . 6527 |
| 14a | . 0026 | . 0362 | . 2653 | . 0146 |
| 14b | . 8502 | . 5257 | . 9653 | . 8685 |
| 15A | . 4721 | . 2974 | . 4955 | . 3631 |
| 158 | . 7203 | . 5910 | . 7240 | . 2414 |
| 150 | . 4733 | . 2752 | . 1972 | . 4199 |
| 150 | . 0001 | . 4484 | . 0198 | . 0089 |
| 15E | . 8516 | . 6031 | . 3705 | . 3760 |
| 15F | . 8163 | . 5533 | . 1576 | . 1781 |
| 15G | . 0829 | . 8008 | . 8913 | . 0164 |
| 16a | . 6565 | . 0108 | . 8181 | . 8613 |
| 16b | . 0683 | . 4092 | . 0001 | . 0083 |
| 17a | . 9334 | . 1563 | . 4835 | . 9798 |
| 17b | . 2240 | . 7239 | . 8079 | . 3669 |
| 18 | . 0034 | . 2678 | . 4836 | . 0292 |
| 19 | . 8638 | . 0185 | . 7863 | . 8099 |
| 20 | . 6078 | . 1657 | . 8845 | . 2738 |
| 21 |  |  |  |  |
| 22 |  |  |  |  |

Resuits of Chi-square test

|  | 4 a | 4b | 5 | 6 | 7 | 8 | 9 | 10A | 10B | 10 C | 100 | 10 E |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 4 a |  |  |  |  |  |  |  |  |  |  |  |  |
| 4b | . 000 |  |  |  |  |  |  |  |  |  |  |  |
| 5 | . 000 | . 270 |  |  |  |  |  |  |  |  |  |  |
| 6 | . 000 | . 236 | . 012 |  |  |  |  |  |  |  |  |  |
| 7 | . 210 | . 071 | . 251 | . 837 |  |  |  |  |  |  |  |  |
| 8 | . 750 | . 087 | . 496 | . 747 | . 472 |  |  |  |  |  |  |  |
| 9 | . 231 | . 141 | . 871 | . 298 | . 843 | . 000 |  |  |  |  |  |  |
| 10A | . 067 | . 564 | . 000 | . 972 | . 256 | . 002 | . 001 |  |  |  |  |  |
| 108 | . 242 | . 905 | . 001 | . 824 | . 127 | . 000 | . 000 |  |  |  |  |  |
| 10C | . 114 | . 136 | . 313 | . 489 | . 734 | . 001 | . 000 |  |  |  |  |  |
| 100 | . 160 | . 320 | . 867 | . 568 | . 148 | . 007 | . 002 |  |  |  |  |  |
| 10E | . 091 | .578 | . 001 | . 972 | . 357 | . 379 | . 014 |  |  |  |  |  |
| 10 F | . 800 | . 330 | 1.00 | . 662 | . 414 | . 124 | . 000 |  |  |  |  |  |
| 10G | . 001 | . 509 | . 037 | . 971 | . 038 | . 000 | . 000 |  |  |  |  |  |
| 10H | . 005 | . 679 | . 674 | . 448 | . 174 | . 007 | . 000 |  |  |  |  |  |
| 101 | . 018 | . 420 | . 546 | . 401 | . 472 | . 028 | . 000 |  |  |  |  |  |
| 11a | . 009 | . 169 | . 000 | . 678 | . 196 | . 635 | . 741 | . 123 | . 003 | . 360 | . 160 | . 013 |
| 11b | . 047 | . 910 | . 713 | . 488 | . 674 | . 335 | . 991 | . 149 | . 539 | . 440 | . 779 | . 424 |
| 12 | . 044 | . 004 | . 121 | . 136 | . 189 | . 034 | . 289 | . 000 | . 001 | . 001 | . 003 | . 283 |
| 13 | . 664 | . 636 | . 406 | . 843 | . 152 | - | . 943 | . 800 | . 636 | . 881 | . 741 | . 818 |
| 14a | . 020 | . 119 | . 727 | . 270 | . 074 | . 158 | . 985 | . 405 | . 013 | . 072 | . 149 | . 355 |
| 14b | . 122 | . 057 | . 113 | . 486 | . 358 | . 582 | . 764 | . 000 | . 001 | . 075 | . 201 | . 516 |
| 15A | . 387 | . 573 | . 915 | . 407 | . 492 | . 666 | . 613 | . 409 | . 161 | . 982 | . 273 | . 136 |
| 158 | . 330 | . 473 | . 408 | . 928 | . 896 | . 340 | . 052 | . 480 | . 236 | . 473 | . 309 | . 149 |
| 15c | . 226 | . 821 | . 689 | . 104 | . 414 | . 777 | . 434 | . 809 | . 615 | . 965 | . 932 | . 821 |
| 150 | . 000 | . 002 | . 001 | . 231 | . 148 | . 158 | . 137 | . 932 | . 031 | . 123 | . 096 | . 037 |
| 15E | . 372 | . 804 | . 196 | . 470 | . 490 | 1.00 | . 034 | . 234 | . 420 | . 268 | . 232 | . 437 |
| 15F | . 201 | . 338 | . 810 | . 755 | . 905 | . 731 | . 076 | . 180 | . 128 | . 054 | . 090 | . 023 |
| 156 | . 308 | . 519 | . 323 | . 317 | . 565 | 1.00 | . 137 | . 974 | . 506 | . 157 | . 256 | . 114 |
| 16a | . 270 | . 449 | . 074 | . 074 | . 379 | . 572 | . 460 c | . 150 | . 114 | . 631 | . 750 | . 178 |
| 16b | . 135 | . 011 | . 007 | . 530 | . 075 | . 946 | . 939 | . 463 | . 656 | . 704 | . 759 | . 877 |
| 17a | . 378 | . 763 | . 289 | . 677 | . 488 | . 251 | . 940 | . 804 | . 822 | . 528 | . 675 | . 835 |
| 17 b | . 834 | . 005 | . 454 | . 456 | . 135 | . 786 | . 129 | . 050 | . 179 | . 614 | . 721 | . 925 |
| 18 | . 630 | . 650 | . 249 | . 918 | . 976 | . 953 | . 005 | . 007 | . 002 | . 041 | . 005 | . 004 |
| 19 | . 371 | . 144 | . 088 | . 051 | . 135 | . 089 | . 280 | . 711 | . 645 | . 351 | . 375 | . 157 |
| 20 | . 484 | . 545 | . 880 | . 983 | . 209 | . 301 | . 990 | 1.00 | . 300 | . 920 | . 899 | . 978 |
| 21 | . 053 | 441 | . 001 | . 572 | . 028 | . 027 | . 138 | . 064 | . 296 | . 190 | . 076 | . 002 |
| 22 | . 480 | 644 | . 001 | . 232 | . 065 | . 378 | . 114 | . 187 | . 732 | . 684 | . 536 | 1.00 |

Results of Chi-square test

|  | 10 F | 106 | 10 H | 101 | 11a | 116 | 12 | 13 | 14a | 146 | 15A | 158 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 4 a |  |  |  |  |  |  |  |  |  |  |  |  |
| 46 |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 |  |  |  |  |  |  |  |  |  |  |  |  |
| 7 |  |  |  |  |  |  |  |  |  |  |  |  |
| 8 |  |  |  |  |  |  |  |  |  |  |  |  |
| 9 |  |  |  |  |  |  |  |  |  |  |  |  |
| 10A |  |  |  |  |  |  |  |  |  |  |  |  |
| 108 |  |  |  |  |  |  |  |  |  |  |  |  |
| 10C |  |  |  |  |  |  |  |  |  |  |  |  |
| 100 |  |  |  |  |  |  |  |  |  |  |  |  |
| 10E |  |  |  |  |  |  |  |  |  |  |  |  |
| 10F |  |  |  |  |  |  |  |  |  |  |  |  |
| 10 G |  |  |  |  |  |  |  |  |  |  |  |  |
| 10H |  |  |  |  |  |  |  |  |  |  |  |  |
| 101 |  |  |  |  |  |  |  |  |  |  |  |  |
| 11a | . 091 | . 000 | . 009 | . 001 |  |  |  |  |  |  |  |  |
| 11b | . 188 | . 199 | . 774 | . 769 | . 000 |  |  |  |  |  |  |  |
| 12 | . 176 | . 019 | . 227 | . 772 | . 182 | . 406 |  |  |  |  |  |  |
| 13 | . 601 | 1.00 | . 974 | . 815 | . 186 | . 524 | . 000 |  |  |  |  |  |
| 14a | . 310 | . 189 | . 014 | . 186 | . 326 | . 017 | . 319 | . 237 |  |  |  |  |
| 14b | . 302 | . 589 | . 289 | . 200 | . 093 | . 675 | . 186 | . 344 | . 000 |  |  |  |
| 15A | . 606 | . 421 | . 188 | 1.00 | . 585 | . 793 | . 009 | . 171 | . 326 | . 029 |  |  |
| 158 | 1.00 | . 088 | . 330 | . 381 | . 673 | . 012 | . 345 | 1.00 | . 091 | . 120 |  |  |
| 15c | . 257 | . 577 | 1.00 | 1.00 | . 582 | . 097 | . 241 | . 098 | . 451 | . 093 |  |  |
| 150 | 1.00 | . 002 | . 084 | . 126 | . 658 | . 173 | . 206 | . 140 | . 210 | . 021 |  |  |
| 15E | . 522 | . 365 | . 671 | . 441 | . 651 | . 705 | . 042 | . 785 | . 228 | . 042 |  |  |
| 15F | . 135 | . 149 | . 075 | . 056 | . 789 | . 595 | . 018 | . 817 | . 023 | . 002 |  |  |
| 156 | 1.00 | . 529 | . 222 | . 186 | . 688 | . 095 | . 204 | . 110 | . 098 | . 044 |  |  |
| 16a | . 251 | . 530 | . 524 | . 524 | . 479 | . 441 | . 105 | . 703 | . 002 | . 000 | . 609 | . 062 |
| 16b | . 030 | 1.00 | . 823 | . 099 | . 347 | . 868 | . 073 | 1.00 | . 036 | . 063 | . 863 | . 073 |
| 17a | . 960 | . 468 | 1.00 | . 314 | . 018 | . 905 | . 084 | . 917 | . 002 | . 015 | . 616 | . 966 |
| 17b | . 018 | . 831 | . 248 | . 052 | . 115 | . 853 | . 540 | . 218 | . 081 | . 005 | . 712 | . 993 |
| 18 | . 258 | . 000 | . 000 | . 021 | . 586 | . 446 | . 196 | . 110 | . 000 | . 000 | . 631 | . 111 |
| 19 | . 869 | . 061 | . 209 | . 286 | . 375 | . 489 | . 005 | . 474 | . 000 | . 014 | . 505 | . 333 |
| 20 | . 523 | . 257 | . 374 | . 500 | . 596 | . 535 | . 305 | 1.00 | . 537 | . 704 | . 440 | . 766 |
| 21 | . 310 | . 000 | . 205 | . 602 | . 000 | . 025 | . 000 | . 863 | . 018 | . 156 | . 331 | . 521 |
| 22 | . 568 | . 013 | . 644 | . 205 | . 019 | . 167 | . 000 | 1.00 | . 516 | . 602 | . 531 | . 213 |

Results of Chi-square test

|  | 15 C | 150 | 15E | 15F | 15 G | 16a | 16b | 17a | 17b | 18 | 19 | 20 | 21 | 22 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 4 a |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4b |  |  |  |  |  | . |  |  |  |  |  |  |  |  |
| 5 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 7 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 8 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 9 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 10A |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 10B |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 10 C |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 100 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 10E |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 10 F |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 10G |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 10H |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 101 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 11a |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 11b |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 12 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 13 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 14 a |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 14b |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 15A |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 158 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 15c |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 150 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 15E |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 15F |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 15G |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 16a | . 638 | . 000 | . 026 | . 285 | . 082 |  |  |  |  |  |  |  |  |  |
| 16b | . 191 | . 004 | . 188 | 1.00 | . 294 | . 000 |  |  |  |  |  |  |  |  |
| 17a | . 817 | . 845 | 1.00 | . 981 | 1.00 | . 000 | . 461 |  |  |  |  |  |  |  |
| 17b | . 529 | . 006 | . 029 | . 119 | . 074 | . 331 | . 000 | . 000 |  |  |  |  |  |  |
| 18 | . 331 | . 008 | . 049 | . 343 | . 003 | . 000 | . 011 | . 665 | . 016 |  |  |  |  |  |
| 19 | . 726 | . 044 | . 948 | . 663 | . 656 | . 689 | . 005 | . 681 | . 166 | . 000 |  |  |  |  |
| 20 | . 736 | 1.00 | . 630 | . 575 | . 189 | . 122 | 1.00 | . 823 | 293 | . 172 | . 090 |  |  |  |
| 21 | . 473 | . 065 | . 214 | . 963 | . 970 | . 275 | . 480 | . 356 | . 007 | . 000 | . 000 | . 046 |  |  |
| 22 | . 105 | . 038 | . 014 | . 642 | . 387 | . 003 | . 155 | . 946 | . 041 | . 000 | . 000 | . 044 | . 000 |  |

Results of F-test (Q.1, 2A, 2B and 3 vs. Each Location of Q.12)

|  | Q.1 | Q.2A | Q.2B | Q.3 |
| :---: | :---: | :---: | :---: | :---: |
| 12 | - | - | - | - |
| $12-1$ | - | - | - | - |
| $12-2$ | Y | - | Y | Y |
| $12-3$ | - | - | Y | - |
| $12-4$ | - | Y | - | - |
| $12-5$ | - | - | - | - |


|  | Q .1 | Q .2 A | Q .2 B | Q .3 |
| :---: | :---: | :---: | :---: | :---: |
| 12 | .3230 | .1286 | .5338 | .2312 |
| $12-1$ | .6784 | .3220 | .6139 | .6407 |
| $12-2$ | .0681 | .9255 | .0361 | .0215 |
| $12-3$ | .7575 | .6044 | .0276 | .5578 |
| $12-4$ | .6368 | .0187 | .5722 | .4100 |
| $12-5$ | .1911 | .3382 | .4582 | .7883 |

Results of Chi-square test (Q. 12 and 13 vs. all others)

|  | 0.12 | 12-1 | 12-2 | 12-3 | 12-4 | 12-5 | Q. 13 | 13-1 | 13-2 | 13-3 | 13-4 | 13-5 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 4 a | . 044 | . 171 | . 875 | . 061 | . 862 | . 186 | . 664 |  |  |  |  |  |
| 4b | . 004 | .110 | . 061 | . 407 | . 020 | . 766 | . 636 |  |  |  |  |  |
| 5 | . 121 | . 175 | . 345 | . 261 | . 375 | . 897 | . 406 |  |  |  |  |  |
| 6 | . 136 | . 034 | . 237 | . 240 | . 578 | . 443 | . 843 |  |  |  |  |  |
| 7 | . 189 | . 042 | . 918 | . 626 | . 062 | . 700 | . 152 |  |  |  |  |  |
| 8 | . 034 | . 596 | . 004 | . 835 | . 567 | . 592 |  |  |  |  |  |  |
| 9 | . 289 | . 627 | . 165 | . 005 | . 674 | . 166 | . 943 | . 495 | . 574 |  |  |  |
| 10A | . 000 | . 189 | . 003 | . 402 | . 000 | . 014 | . 800 | . 381 | 1.00 |  |  |  |
| 10B | . 001 | . 409 | . 001 | . 038 | . 000 | . 000 | . 636 | . 066 | . 811 |  |  |  |
| 10 C | . 001 | . 743 | . 001 | . 036 | . 034 | . 091 | . 881 |  |  |  |  |  |
| 100 | . 003 | . 398 | . 067 | . 235 | . 110 | . 136 | . 741 |  |  |  |  |  |
| 10E | . 283 | . 613 | . 225 | . 220 | 1.00 | . 214 | . 818 |  |  |  |  |  |
| 10F | . 176 | . 922 | . 166 | . 154 | . 623 | . 188 | . 601 |  |  |  |  |  |
| 10G | . 019 | . 681 | . 008 | . 022 | . 879 | . 438 | 1.00 |  |  |  |  |  |
| 10H | . 227 | . 855 | . 202 | . 116 | . 123 | . 009 | . 974 |  | 1.00 |  |  |  |
| 101 | . 772 | . 629 | . 082 | . 789 | . 786 | . 129 | . 815 |  | 1.00 |  |  |  |
| 11a | . 182 | . 104 | . 003 | . 782 | . 559 | . 327 | . 186 |  | . 529 |  |  |  |
| 11b | . 406 | . 230 | . 044 | . 420 | . 043 | . 780 | . 524 |  |  |  |  |  |
| 13 | . 000 | . 030 | . 078 | . 335 | . 110 | . 863 |  |  |  |  |  |  |
| 14a | . 319 | . 426 | . 067 | . 053 | . 327 | . 010 | . 237 | . 679 | . 434 |  |  | . |
| 14b | . 186 | . 822 | . 135 | . 123 | . 206 | . 007 | . 344 | . 428 | . 259 |  |  |  |
| 15A | . 009 | . 833 | . 206 | . 279 | . 005 | . 253 | . 171 |  |  |  | $\bigcirc$ |  |
| 158 | . 345 | . 628 | . 058 | . 117 | 1.00 | . 447 | 1.00 |  | . 954 |  |  |  |
| 150 | . 241 | . 154 | . 011 | 1.00 | . 575 | . 585 | . 098 |  |  |  |  |  |
| 150 | . 206 | . 246 | . 745 | . 001 | . 594 | 1.00 | . 140 |  | . 364 |  |  |  |
| 15E | . 042 | . 261 | . 658 | . 512 | . 593 | . 976 | . 785 |  |  |  |  |  |
| 15F | . 018 | . 255 | . 461 | . 400 | . 215 | . 816 | . 817 |  |  |  |  |  |
| 156 | . 204 | . 674 | . 229 | . 647 | 1.00 | 1.00 | . 110 |  |  |  |  |  |
| 16a | . 105 | . 018 | . 266 | . 837 | . 101 | . 084 | . 703 |  |  |  |  |  |
| 16b | . 073 | . 115 | . 067 | 1.00 | . 252 | . 316 | 1.00 |  | . 952 |  |  |  |
| 17a | . 084 | . 572 | 1.00 |  | . 315 |  | . 917 |  |  |  |  |  |
| 17b | . 540 | . 194 | . 672 | . 115 | . 645 | . 337 | . 218 |  |  |  |  |  |
| 18 | . 196 | 1.00 | . 208 | . 038 | . 415 | . 002 | . 110 |  |  |  |  |  |
| 19 | . 005 | . 002 | . 358 | . 095 | . 164 | . 023 | . 474 |  | . 575 |  |  |  |
| 20 | . 305 | 1.00 | . 202 | . 532 | . 740 | . 290 | 1.00 |  |  |  |  |  |
| 21 | . 000 |  |  |  |  |  | . 863 |  |  |  |  |  |
| 22 | . 000 |  |  |  |  |  | 1.00 |  |  |  |  |  |

Note: Empty cells show that cell frequency was not enough for Chi-square test.


[^0]:    Question 2b: How many of those miles were in Illinois? Answer in thousand miles.

    | DRIVILII | Frequency | Percent | Cumulative <br> Frequency | Cumulative <br> Percent |
    | :---: | :---: | :---: | :---: | :---: |
    | 0 | 30 | 4.2 | 30 | 4.2 |
    | 1 | 21 | 2.9 | 51 | 7.1 |

