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Final Report

**ANALYSIS OF TRUCK DRIVERS' OPINIONS ON
SAFETY AND TRAFFIC CONTROL ON HIGHWAY
WORK ZONES**

Volume I. Summary of Findings

by

**Rahim F. Benekohal
Eunjae Shim
Paulo T. V. Resende**

A Cooperative Investigation
conducted by the

**DEPARTMENT OF CIVIL ENGINEERING
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
205 N. Mathews Ave.
Urbana, IL 61801**

In Cooperation with the

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16. Abstract 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. 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' 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 were used for data analysis. The following two reports contain the findings of this study: <ol style="list-style-type: none"> 1. Analysis of Truck Drivers' Opinions on Safety and Traffic Control on Highway Work Zones, Volume I, Summary of Findings, Final Report, December 1995. 2. Analysis of Truck Drivers' Opinions on Safety and Traffic Control on Highway Work Zones, Volume II, Final Report, December 1995. Volume I of this report contains the summary of findings, conclusions, and recommendations of the study. The readers who are interested in more details should also read Volume II of this report.					
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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.

TABLE OF CONTENTS

ACKNOWLEDGMENT AND DISCLAIMER	iii
INTRODUCTION	1
STUDY APPROACH AND FINDINGS	2
Data Analysis	2
Driving Experience and Age	2
Miles Traveled in the U.S. and Illinois	6
Types of Trucks and Carriers	8
Time of Driving	8
Type of Permits	8
Advance Signing of Work Zones	9
Hazard of Traveling Through Work Zones	9
Preferred Work Zone Configuration	10
Assessment of Work Zone Features	10
Speed Limits in Work Zones	13
Flagger's Visibility	13
Flagger's Directions	14
Traffic Control Devices	15
Arrow Boards	16
Changeable Message Boards	17
Unclear or Confusing Signs in Illinois Work Zones	18
Need to Add Signs or Messages to Work Zones	18
ACCIDENT AND BAD DRIVING SITUATIONS IN WORK ZONES	19
Accidents	19
Bad Driving Situations in Overall Work Zones	20
BDS in Advance Warning Area	21
BDS in Transition Area	21
BDS in Buffer Space	22
BDS in Work Space	22
BDS in Termination Area	22
ILLINOIS VS NON-ILLINOIS DRIVERS	23
SUMMARY AND CONCLUSIONS	23
RECOMMENDATIONS	28
REFERENCES	29
APPENDIX A. Questionnaire	30

INTRODUCTION

In 1993 in Illinois, 1,903 vehicles were involved in fatal crashes, of which 153 were large trucks [1, 2]. In 1992 in Illinois, large trucks were involved in 15,321 crashes, of which 100 were fatal. There were 9,949 work zone crashes in Illinois in 1992, of which 29 were fatal and 2,422 were injury type [3]. The fatal accident rate of semi-trucks in Illinois was 61% higher, but total crash rate was 25% lower than all vehicles [4]. 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. The work zone accident frequencies in terms of vehicle miles traveled (VMT) or another suitable exposure rate 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.

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 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.

This report contains the summary of findings, conclusions, and recommendations of the final report of this study entitled "Analysis of Truck Drivers' Opinions on Safety and Traffic Control on Highway Work Zones, Volume II." The readers who are interested in more details should also read Volume II of this report. A brief discussion of the travel characteristics and accident experiences is also given in Benekohal et al [5].

STUDY APPROACH AND FINDINGS

Statewide surveys of semi-truck drivers were conducted from 9 am to 5 pm on weekdays in September and October of 1993. A survey instrument was developed in collaboration with the Illinois Department of Transportation (IDOT). The questionnaire contained 43 questions about truck drivers and travel characteristics, drivers' 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. A copy of the questionnaire is given in Appendix A.

The data collection sites were selected such that near every data collection site there was at least one construction zone. Data were collected in the areas of Danville (I-74), Bloomington (I-74), Morton (I-74), Springfield (I-55), Chicago/Joliet (I-80), and Effingham (I-57) in Illinois. These locations were spread over the entire state and is believed to represent the truck drivers on Illinois Interstate Highways. The survey questionnaires were handed to the truck drivers (no pickups) and were collected after they were completed. About 930 truck drivers participated in the survey, and 834 of the surveys forms were found suitable for further data analysis.

☛ Data Analysis

- The frequency of the responses to each question was analyzed. Summaries of the frequency of responses are given in Tables 1-3 . Also correlation analyses were conducted to identify significant relationships among the surveyed items. Different statistical tests such as the test of significance of correlation coefficients, the *F*-test, ANOVA, and the χ^2 goodness-of-fit test were used for data analysis.

☛ Driving Experience and Age

- Average age of truck drivers was 43.0 years old and the range was from 20 to 68 years old. Their driving experience varied from 0 to 48 years with an average of 16.1 years. There was a relatively strong positive correlation between age and their driving experience, indicating that most of the drivers started truck driving profession when they were younger.
- Age and driving experiences were correlated to the type of truck driven. The average age of

Table 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%)	Nighttime (2%)	-
Permit	No (79%)	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%)	Same (8%)	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	46-50 mph (34%)	At 45 mph (30%)	< 45 mph (19%)	> 50 mph (17%)
Visibility of Flaggers	OK (44%)	Hard to See (32%)	Very Visible (19%)	No Opinion (5%)
Direction by Flaggers	Clear (46%)	Sometime Confusing (37%)	Most Times Confusing (12%)	No Opinion (5%)
Height of Arrow Boards	OK (76%)	Too High (15%)	Too Low (5%)	No Opinion (4%)
Brightness of Arrow Boards	Too Bright (76%)	OK (22%)	Not Bright Enough (1%)	No Opinion (1%)
Height of Changeable Message Boards	OK (86%)	Too Low (5%)	Too High (4%)	No Opinion (5%)
Brightness of CMB	OK (72%)	Too Bright (18%)	Not Bright Enough (7%)	No opinion (3%)
Unclear/Confusing Signs	Yes (14%)	No (86%)	-	-
Add Signs	Yes (22%)	No (78%)	-	-
Drove through Work Zone(s) Today	Yes (94%)	No (6%)	Don't Remember (0%)	-
Suggestions	Yes (59%)	No (41%)	-	-
Comments	Yes (30%)	No (70%)	-	-

Table 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	No Opinion ⁵
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. 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 3. Frequencies of Responses to Questions on Traffic Control Devices

TCD	Very Helpful ¹	Somewhat Helpful ²	Helpful ³	Don't Like Their Use ⁴	No 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 Barricades	44.3%	38.1%	82.4%	12.6%	5.0%
Concrete 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 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.

the double-bottom truck drivers was the highest and that of box van drivers was the lowest. Also, double-bottom truck drivers had more driving experience than box van drivers.

- The less experienced drivers wanted, in general, to find out about the WZ far in advance than the more experienced drivers. The average age of drivers who wanted to know about a work zone 2 or less miles ahead was higher than those who wanted it 3 or more miles ahead.
- Assessment of hazard of traveling in the WZ was correlated with truck driving experience. Drivers who said traveling in the WZ is more hazardous than non-work zones were less experienced than those who said the hazard is the same.
- The average age and experience of drivers who preferred one-lane closure was lower than those who had no preference between lane closure and median crossover.
- The average experience of drivers who felt uncomfortable with work zone features such as median crossovers, lack of shoulders, pavement edge dropoff, loose construction materials, lane width, or driving in "S" curves was lower than those who did not feel uncomfortable. However, the average age of drivers who felt uncomfortable with merging to an open lane, blowing dirt or dust, or lane closure taper length was higher than those who did not feel uncomfortable.
- Drivers who said that the 55 mph speed limit in WZ is too fast, were older and more experienced than those who said it is about right or is too slow. Similarly, in WZ with a 45 mph speed limit, these drivers said they travel at slower speeds. Their travel speed seem to be a function of their age or experience - the lower the age or experience the higher the travel speed.
- The average age and experience were higher for drivers who said the flaggers are hard to see, concrete barriers and impact attenuators are helpful, arrow boards are too bright, and confusing and unclear signs exist in the WZ.

☛ Miles Traveled in the U.S. and Illinois

- The total miles driven per year was 112,000 miles in average and the range was from 0 to 290,000 miles. The average of miles driven in Illinois was 25,000 miles and the range was from 0 to 250,000 miles. It was found that there are no strong relations between the miles driven in Illinois and in US.

- Average miles driven by truck drivers were correlated with the truck and carrier type. Box van or double bottom drivers traveled more miles in the U.S. than flatbed or special purpose truck drivers; also box van traveled more miles than tankers. Miles traveled in Illinois by double bottom, tanker or special purpose truck drivers were higher than that by box van or flatbed drivers. In Illinois, the private carrier traveled more miles than the common or contract carriers.
- Miles driven in US by those who drove all-hours was higher than those who drove during daytime. However, daytime drivers drove more than all-hour drivers in Illinois.
- Those who did not have a preferred work zone configuration drove more in the U.S. than the ones who preferred median crossovers or one-lane closure.
- Miles traveled in the US was higher for drivers who said that merging to an open lane, median crossovers, lack of shoulders, blowing dirt or dust, or lane width did not make them feel uncomfortable. Those who drove more last year in Illinois mentioned that median crossovers did not make them feel uncomfortable.
- Drivers who mentioned that the 55-mph speed limit in work zones is about right drove more miles in the US than those who said that the speed limit is too slow. Similarly, those who said that it is too fast drove more miles in Illinois than those who said that it is too slow. Thus, drivers who indicated that the speed limit is too slow did not travel more miles than those who considered it about right or too fast, but wanted to travel faster.
- Drivers who indicated that they drove at speeds higher than 50 mph in work zones with 45 mph speed limit drove more in the US than the other groups. However, the average miles driven in Illinois for those who indicated that they drive below 45 mph were higher than that of those who drive 56-60 mph.
- Accident experience in the work zones was related to the number of miles driven in Illinois. Drivers who had accidents drove more miles in Illinois than those who had no accidents.
- Drivers who indicated that flaggers are hard to see, arrow board is too low, or additional WZ signs are needed drove more miles in the US than those that disagreed with them. Similarly, drivers who mentioned that the arrow board's brightness is okay drove more miles in Illinois than those who indicated that arrow boards are too bright. Drivers who considered concrete barriers as helpful drove more in Illinois than those who said that they do not like their use.

☛ Types of Trucks and Carriers

- Box van was the most cited (55%) type of truck, followed by flatbed/platform (13%), tanker/chemical (7%), and double-bottom (7%). Common carrier was the largest carrier type (62%) which drivers worked for, followed by contract (18%), private (12%). The average number of trucks per company was approximately 930 trucks and the range was from 1 to 25,000 trucks.
- More box van drivers felt uncomfortable about lane width, driving in "S" curves, or lane closure taper length; thought 55-mph speed limit is about right; traveled above 50 mph in a 45-mph speed limit; or did not like the use of concrete barriers.
- A higher proportion of flatbed drivers said flaggers are hard to see, but a higher proportion of double bottom drivers said they are very visible.
- More double-bottom drivers work for common carriers; feel uncomfortable in merging to an open lane, driving in "S" curves, or lane closure taper length; think 55-mph speed limit is too fast; and have experienced bad driving situations in work zones.
- A higher proportion of common carrier drivers said they had experienced bad driving situation in work zones, but said the hazard of driving through work zones is the same as non-work zones.

☛ Time of Driving

- Most of the truck drivers (88%) usually travel all hours, about 10% usually drive in daytime, and 2% usually drive at nighttime (2%).
- A higher proportion of daytime drivers carry over-dimension permits; feel uncomfortable in merging to an open lane, using median crossover, or seeing loose construction materials on an open lane; and think 55-mph speed limit is too slow. However, a lower proportion of daytime drivers said concrete barriers are helpful, think arrow boards are too high or too bright, or indicate that more signs or messages are needed in Illinois work zones.

☛ Type of Permits

- About 79% of drivers were not carrying loads that require permits at the survey time. However, 15% had hazardous material related permits, 5% had over-dimension permits, and

1% had both hazardous materials and over-dimension related permits.

- A higher proportion of drivers carrying hazmat permits think that the arrow boards are too high, or signs or messages should be added to work zones. However, a lower proportion of drivers with over-dimension permits indicate that signs or messages should be added to work zones.

☛ Advance Signing of Work Zones

- About 47% of drivers said that the first work zone signs should be posted 3-5 miles ahead, 34 % wanted it 1-2 miles ahead, and 14% wanted it 6-10 miles ahead. Only 5% said that it should be posted less than 1 mile or more than 10 miles ahead.

☛ Hazard of Traveling Through Work Zones

- A large majority of truck drivers (90%) said work zones are more hazardous than non-work zone areas. This value is very high compared to the findings of a previous study (10,11), in which 54% of all drivers (included 16% truck drivers) said that traveling through work zones was more hazardous.
- Drivers who indicated that work zones are more hazardous than non-work zones were over-represented among drivers who prefer the one-lane closure to median crossover, as well as among drivers who said work zone features such as merging to an open lane, median crossover, lack of shoulder, pavement edge dropoff, lane width, driving in "S" curve, and lane closure taper length, make them uncomfortable. However, drivers who perceive the hazard of traveling in work zones to be the same as in non-work zones were under-represented among drivers who feel these work zone features do not make them uncomfortable, as well as among those who said more signs should be added to the WZ.
- The perception of hazard in work zones was correlated with experiencing bad driving situations in work zones. Drivers who replied that the hazard in the WZ is the same as non-WZ were under-represented in those who indicated that they have experienced bad driving situations in work zones. However, drivers who perceived WZ to be more hazardous were over-represented in those who said they have experienced bad driving situations in work zones.

☛ Preferred Work Zone Configuration

- 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 prefer one-lane closure were over-represented among those who said all the listed work zone features (merging to an open lane, median crossovers, lack of shoulders, pavement edge dropoff, loss construction materials, blowing dirt or dust, lane width, driving in "S" curves, and lane closure taper length) make them feel uncomfortable.
- Drivers who prefer median crossovers were over-represented among those who said all the listed work zone features, except median crossover and driving in "S" curves, make them feel uncomfortable. A higher proportion of them also do not like the use of barricades, barrels and/or tubes.
- Drivers who have no preferred work zone configuration were under-represented among those who said the work zone features do not make them feel uncomfortable, or said that there are unclear or confusing signs in the work zones.
- Drivers who prefer median crossovers or one-lane closure were over-represented among those who mentioned that there are unclear or confusing signs in the Illinois work zones.

☛ Assessment of Work Zone Features

- Drivers were asked to indicate if any of the following work zone features make them uncomfortable when traveling through work zones. The work zone features are: merging to an open lane, median crossovers, lack of shoulders, pavement edge dropoff, loose construction materials in the open lane, blowing dirt or dust, lane width, driving in "S" curves, and lane closure taper length. All of the work zone features make 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.
- MERGE- The assessment of the uncomfortableness of merging to an open lane was correlated with the experience of bad driving situations in work zones, clarity of directions given by flaggers, the brightness of changeable message boards, and the presence of unclear or

confusing signs in WZ. 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, those who felt that the directions given by flaggers are confusing, those who felt that changeable message boards are too bright, or those who saw unclear or confusing signs in the Illinois work zones.

- **CROSSOVERS-** How comfortable a truck driver feels about median crossovers in work zones was correlated with six items in the survey. These items are the speed limit of 55 mph in work zones, the experience of bad driving situations in work zones, the visibility of flaggers, the direction 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, those who had experienced bad driving situation in work zones, those who said that concrete barriers are not useful, those who said that there are unclear or confusing signs, 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.
- **SHOULDERS-** The uncomfortable feeling due to the lack of shoulders in work zones was correlated with the experience of bad driving situations in work zones, the visibility of flaggers, the direction given by flaggers, the usefulness of tubes, and the presence of unclear or confusing signs in Illinois work zones. 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 the 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 they were under-represented in those who do not like the use of tubes in WZ.
- **EDGE DROPOFF-** The responses to the pavement edge dropoff question were correlated with the experience of bad situations in WZ, the usefulness of concrete barrier and tubes, and the presence of unclear or confusing signs in WZ. 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 WZ. Drivers who said that pavement edge dropoff does not make them feel uncomfortable were under-represented in those who do not like concrete barriers or tubes in WZ.

- **LANE WIDTH-** The responses to lane width 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 said the concrete barriers are helpful. 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 to WZ.
- **"S" CURVES-** Drivers who indicated that driving in "S" curves does not make them uncomfortable were over-represented 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.
- **TAPER LENGTH-** The assessment of discomfort level due to lane closure taper length 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, but were under-represented in those who do not like the use of tubes or those who feel that the arrow boards, or Changeable message boards (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 Limits in Work Zones

- About 62% of drivers said that the speed limit of 55-mph in work zones is about right, 25% said it is too fast, and 8% said it is too slow. Drivers were also asked to indicate how fast they drive in work zones with a 45-mph speed limit. Approximately 34% said they drive in the range of 46-50 mph, 30% at 45 mph, 19% at below 45 mph, and 18% over 50 mph. Thus, half of the drivers travel at or below the speed limit of 45-mph while the other half would exceed it.
- The assessment of an appropriate work zone speed limit and the travel speed in a work zone with a 45-mph speed limit were correlated. Drivers who said that the 55 mph speed limit is too slow 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. Drivers who agreed with the 55 mph speed limit in work zones were over-represented 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.
- A higher proportion of drivers who said that the 55 mph speed limit in work zones is too slow said that the directions given by flaggers are confusing most of the time, and that the height of changeable message boards are too low.
- Drivers who travel below 45 mph at 45-mph speed limit were over-represented in those who said that flaggers are hard to see.
- Drivers who travel in work zones at 45-50 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 over-represented in that group. Drivers who travel in work zones at 45 mph or below were under-represented 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.

☛ Flagger's Visibility

- About 63% of drivers said that the visibility of flaggers is either okay or they are very visible, however 32% said the flaggers are hard to see. The flagger's visibility was correlated with the clarity of directions given by him/her, the usefulness of barricades, tubes and impact

attenuators, the height and brightness of arrow boards and changeable message signs, presence of unclear or confusing signs, and the need for adding signs to Illinois work zones.

- Drivers who said that flaggers are very visible were over-represented in a group who said that the directions are very clear. Furthermore, drivers who said that flaggers' visibility is okay were under-represented in those who said that directions are confusing most of the times. 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 said that flaggers are hard to see were over-represented among 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 flaggers are very visible were under-represented in those who answered that arrow boards are too high/low or too bright, and were over-represented in those who said that the brightness of arrow boards is okay. Thus, they do not seem to have a problem with the brightness of arrow boards. Drivers for whom flaggers were hard to see were over-represented in those who mentioned that the arrow boards are too high/low, but they were under-represented in those who answered that the brightness of arrow boards is okay. 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.
- Drivers who indicated that flaggers are very visible or their visibility is okay were under-represented among those who indicated that there are unclear or confusing signs, as well as among those who wanted additional signs in WZ. However, drivers who indicated that 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.

☛ **Flagger's Directions**

- While 46% of drivers said the directions given by flaggers are usually clear, 49% said the directions are confusing sometimes or most of the times. In another survey Benekohal et al. found that about 88% of the respondent (mostly car drivers) correctly identified the flaggers message from the list of responses. This indicates that the directions given are not always

clear and need some improvements.

- Assessment of the clarity of directions given by flaggers were correlated with responses to traffic control devices such as cones, white plastic barricades, concrete barriers, barrels, tubes, and impact attenuators, the height and brightness of arrow boards and changeable message boards, unclear or confusing signs, and the need to add additional signs to the Illinois work zones.
- Drivers who said that the 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 times were over-represented in those who mentioned that the six traffic control devices are not helpful.
- 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, but were under-represented in those who indicated that the height or the brightness of arrow boards is okay.
- Drivers for whom the directions are sometimes confusing were under-represented in those who said that the CMB are too low, and they were over-represented in those who indicated that CMB are not bright enough. Within the category of drivers who replied that the directions are most of the times confusing, those who mentioned that CMB are too low or too bright were over-represented. Finally, drivers said directions given by flaggers were very clear were over-represented in those who said the brightness of changeable message signs is not enough.
- Drivers who said the flagger's directions are usually clear were under-represented, but drivers who said the directions are confusing most of the times were over-represented among those who indicated that there are unclear or confusing signs in the Illinois work zones. Also, drivers who said the directions are confusing (sometimes and most of the times) were over-represented in those who mentioned that signs should be added to the Illinois work zones.

☛ Traffic Control Devices

- 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.

- 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.
- Drivers who considered the concrete barriers as helpful were under-represented and drivers who considered them not helpful were over-represented among those who said the height of arrow boards is either too low or too high. Also, drivers who said the concrete barriers are helpful were under-represented in those who mentioned that arrow boards brightness is okay.
- Drivers who said the concrete barriers are helpful were under-represented and drivers who said that the concrete barriers are not helpful were over-represented in those who said that CMB are too bright.
- Drivers who said the concrete barriers are helpful were under-represented and those who said the barriers are not helpful were over-represented among those who said some signs are unclear or confusing, and additional signs are in needed in WZ.
- Drivers who do not like the use of barrels were over-represented in those who thinks arrow boards as either too high or too low, and they were under-represented in those who said that their height is okay. Drivers who believes that barrels are helpful were under-represented in those who think that changeable message signs are too bright. Drivers who do not like the presence of barrels were over-represented in those who mentioned that there are confusing or unclear signs in WZ.
- Drivers who did not like the use of impact attenuators were over-represented in those who thinks arrow boards are too high, CMB are not bright enough, or unclear or confusing signs exist in WZ.

☛ Arrow Boards

- Most (76%) truck drivers said the height of arrow boards is okay, however 15% said it is too high and 5% said it is too low. On the other hand, 76% of drivers said the arrow boards are

too bright. The height of arrow boards was highly correlated with their brightness, the height of changeable message signs, and existence of unclear or confusing signs in WZ. The brightness concerns need to be examined to increase the effectiveness of arrow boards and/or reduce their disturbing effects.

- Drivers associated the brightness concerns to the height of arrow board. Drivers who thought the arrow boards are too high or too low were over-represented among those who indicated that arrow boards are too bright. Furthermore, among drivers who said the height is okay, drivers who said brightness of arrow boards is okay were over-represented.
- The responses to heights of arrow boards and changeable message signs were also found correlated. 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 under-represented in those who mentioned that changeable message signs is too low.
- Drivers who said that arrow boards are either too high or too low were over-represented and drivers who said the arrow boards' height is okay were under-represented among those who indicated that there are unclear or confusing signs in WZ.
- The responses to brightness of arrow boards was also found correlated with the brightness of changeable message signs. Drivers who said arrow boards are too bright were over-represented in those who said that changeable message signs are too bright. 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.
- 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 WZ, or that new signs should be added to them.

☛ Changeable Message 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. The height was correlated with the brightness of CMB.
- Drivers who said that the height of CMB is too low were over-represented, and drivers who

the height is okay were under-represented among those who indicated that CMB are not bright enough.

- Drivers who said CMB 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 said the brightness of changeable message signs is okay were under-represented in that group.

☛ **Unclear or Confusing Signs in Illinois Work Zones**

- Most of the truck drivers (86%) said that there are not any confusing or unclear signs in Illinois work zones. 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. 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. Drivers want to know which lane is closed. Truck only lanes changing 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. Some drivers find that exits in construction zones are not marked clearly. They complain that signs remain in effect when no work is going on, after construction is completed, conditions have changed, or construction has not yet begun.
- The presence of unclear or confusing signs in the Illinois work zones was also found correlated with the need for adding new signs to construction areas. Drivers who said that there are unclear or confusing signs in WZ were under-represented in those who indicated that new signs should be added to work zones.

☛ **Need to Add Signs or Messages to Work Zones**

- About 78% of drivers said that there is no need to add signs or messages to Illinois work zones, but 22% said some signs should be added. They suggested adding signs about early

merging, more merge signs, merge signs accompanied by law enforcement officers, early notification of work zones, road conditions of the open lane in work zones (such as width, uneven pavement, and shoulder drop-offs), construction length, and speed limits. They also would like to see the type of work, lane-closed-ahead signs specifying which lane is closed, signs displaying the distance to the lane closure, and no passing zones when a lane is closed ahead.

They recommended signs instructing drivers to slow down in work zones, and some proposed more speed limit signs.

ACCIDENT AND BAD DRIVING SITUATIONS IN WORK ZONES

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.

Accidents

- A relatively small percentage (6.1%) said that they had accidents in one or two locations in work zones. About 1% had experienced accidents in two locations, which include either the advanced warning area or the transition area. Accidents were distributed among the five areas, but mainly were in the advanced warning and transition areas.
- 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, 8% in the termination area, and 7% in the buffer space.
- Accident experience was correlated to the experience of bad driving situations (BDS), 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.
- 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 over-represented. For buffer space and termination areas a significant relationship between accident and BDS experiences was not detected.

- 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.

☛ **Bad Driving Situations in Overall Work Zones**

- Approximately 66% of the drivers said that they had experienced bad driving situations (BDS) at least in one location, and 29% had experienced BDS in more than one location in work zones. The transition area had the highest proportion of BDS (43%), followed by the advanced warning area (24%), the work space (13%), the termination area (11%), and the buffer space (9%).
- BDS in work zones was related to the accident experience in work zones, to some traffic control devices (cones, barrels and tubes), the brightness of arrow boards, the height of changeable message boards, and the need for adding new signs in the Illinois work zones. Drivers who had experienced BDS in work zones had more accidents in work zones than those who had not BDS. They were over-represented among those who do not like the use of cones, barrels, or tubes; those who said CMBs are too high; or those who said that new signs should be added to the Illinois work zones. They were under-represented among those who said arrow boards are too bright.
- Considering overall experience of BDS in work zones, common carrier drivers and double-bottom truck drivers were over-represented, while chemical/tanker drivers were under-represented.
- The perception of hazard in WZ was related to the experience BDS in WZ. Those who perceived WZ to be more hazardous were over-represented among those who experienced BDS in the WZ.
- 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.

- 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 need to be determined. Issues related to flagger 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.

☛ **BDS in Advance Warning Area**

- The experience of BDS in advanced warning areas was correlated with five items in the survey. These items are the type of permits carried by drivers, advanced signs about work zones, accident experiences in work zones, opinions about arrow boards height, and the need for adding signs in the Illinois work zones. 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 find out about WZ in less than 1 mile ahead, or desired additional signs were over-represented.

☛ **BDS in Transition Area**

- 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 have experienced BDS in transition areas were over-represented in those who think arrow boards are too bright. However, they were under-represented in those who drive trucks for private carriers, perceived that hazard in WZ is the same as non-WZ, or those who said flaggers are very visible were under-represented.
- The driving experience and age were significant factors in facing BDS in TRA. The younger drivers and drivers who had less driving experience were over-represented among those drivers who had BDS in TRA.
- 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.

☛ BDS in Buffer Space

- Drivers who have experienced BDS in buffer space were over-represented in those who drive flatbed or lowboy, 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 felt that more signs are needed in the work zones. However, they were under-represented 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.

☛ BDS in Work Space

- Drivers who have experienced BDS in work space were over-represented among those who had lower VMT, drove trucks for common carriers, those who wanted 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, or those who did not like the use of cones.
- Drivers who have experienced BDS in work space were over-represented among those who travel below 45 mph or at 51-55 mph in work zones of 45 mph speed limit. However, they were under-represented in those who drive 46-50 mph in 45-mph speed limit areas. This seems to indicate that those who deviated from the "group" speed end up experiencing BDS in WKS more often.

☛ BDS in Termination Area

- 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.

ILLINOIS VS NON-ILLINOIS DRIVERS

- Two categories of drivers were identified based on the annual miles driven in Illinois and US- "Illinois drivers" and "non-Illinois drivers." Based on the annual miles driven in Illinois and U.S. and their ratio, the 119 Illinois-drivers and 180 non-Illinois-drivers were identified and their opinions were compared.
- Average driving experiences and miles driven in US for the Illinois-drivers were less than non-Illinois-drivers.
- Illinois-drivers were under-represented in those who drove box van, but were over-represented in those who drove double bottom, tanker/hopper, chemical, or special purpose trucks.
- 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.
- Illinois drivers were over-represented in those who drove trucks usually during daytime, 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 said that lack of shoulders or lane closure taper length did not make them feel uncomfortable when driving through work zones, as well those who did not like concrete barriers in work zones.
- 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.
- 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.

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 [6, 7] 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 non-work 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-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 double-bottom truck drivers were over-represented, while chemical/tanker drivers were under-represented. 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 over-represented.

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 mph in work zones of 45 mph speed limit, or those who did not like the use of cones. However, they were under-represented among those who were driving trucks for private carriers, or those who drive 46-50 mph in 45-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 over-represented. 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 under-represented 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. Questionnaire

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

**PLEASE CIRCLE THE ITEM(S) THAT BEST ANSWER
EACH QUESTION OR FILL IN THE BLANKS.
THANK YOU, WE APPRECIATE YOUR HELP.**

#:
Loc:

1. HOW LONG HAVE YOU DRIVEN A TRUCK? _____ years
- 2a. HOW MANY MILES DID YOU DRIVE A TRUCK LAST YEAR? _____ miles
- 2b. HOW MANY OF THOSE MILES WERE IN ILLINOIS? _____ miles
3. HOW OLD ARE YOU? _____ years
- 4a. WHAT TYPE OF TRUCK ARE YOU DRIVING?
- | | | |
|----------------------------|-------------------------------|---------------------------|
| A. <i>Box van</i> | F. <i>Flatbed or Platform</i> | K. <i>Chemical</i> |
| B. <i>Dump</i> | G. <i>Lowboy</i> | L. <i>Other (specify)</i> |
| C. <i>Double Bottom</i> | H. <i>Grain</i> | _____ |
| D. <i>Pole</i> | I. <i>Livestock</i> | |
| E. <i>Tanker or Hopper</i> | J. <i>Auto-Transport</i> | |
- 4b. WHAT TYPE OF CARRIER IS THE COMPANY YOU CURRENTLY DRIVE FOR?
- | | |
|--------------------|----------------------------|
| A. <i>Common</i> | D. <i>Exempt</i> |
| B. <i>Contract</i> | E. <i>Other (specify):</i> |
| C. <i>Private</i> | _____ |
- 4c. WHAT IS THE NUMBER OF TRUCKS YOUR COMPANY OPERATES? _____ trucks
5. WHEN DO YOU USUALLY DRIVE A TRUCK?
- | |
|---------------------|
| A. <i>Daytime</i> |
| B. <i>Nighttime</i> |
| C. <i>All hours</i> |

6. ARE YOU CARRYING LOAD THAT REQUIRES A PERMIT? (CIRCLE ALL THAT APPLY)

- A. No
- B. Yes - overweight
- C. Yes - overheight
- D. Yes - overwidth

- E. Yes - Hazardous materials
- F. Other (specify):

7. HOW MANY MILES IN ADVANCE WOULD YOU LIKE TO FIND OUT ABOUT A WORK ZONE AHEAD?

- A. Less than 1
- B. 1-2
- C. 3-5

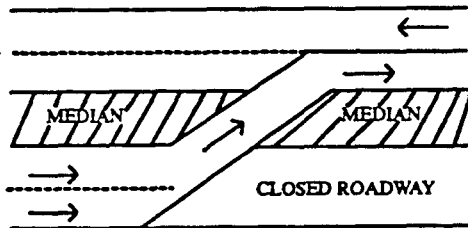
- D. 6-10
- E. Other (specify):

8. HOW HAZARDOUS IS DRIVING A TRUCK THROUGH WORK ZONES COMPARED TO NON-WORK ZONES?

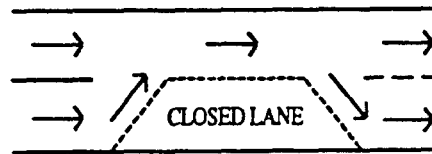
- A. More hazardous
- B. Less hazardous

- C. About the same
- D. I don't know

9. CONSTRUCTION ZONES USUALLY HAVE A MEDIAN CROSSOVER OR ONE-LANE CLOSURE AS SHOWN BELOW:



Median Crossover

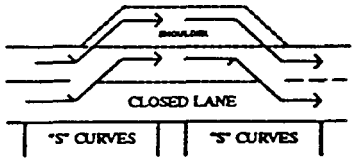
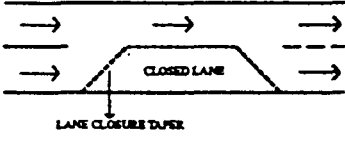


One-Lane Closure

HOW DO YOU 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

10. DO ANY OF THESE ITEMS MAKE YOU FEEL UNCOMFORTABLE WHEN YOU DRIVE THROUGH WORK ZONES? (CIRCLE ONE ANSWER FOR EACH ITEM).

	<i>IT DOES NOT</i>	<i>SOMETIMES</i>	<i>MOST OF THE TIMES</i>	<i>NO OPINION</i>
A. <i>Merging to an open lane</i>	1	2	3	4
B. <i>Median Crossovers</i>	1	2	3	4
C. <i>Lack of shoulders</i>	1	2	3	4
D. <i>Pavement edge dropoff</i>	1	2	3	4
E. <i>Loose construction materials on open lane</i>	1	2	3	4
F. <i>Blowing dirt or dust</i>	1	2	3	4
G. <i>Lane width</i>	1	2	3	4
H. <i>Driving in "S" Curves</i>				
	1	2	3	4
I. <i>Lane Closure Taper Length</i>				
	1	2	3	4

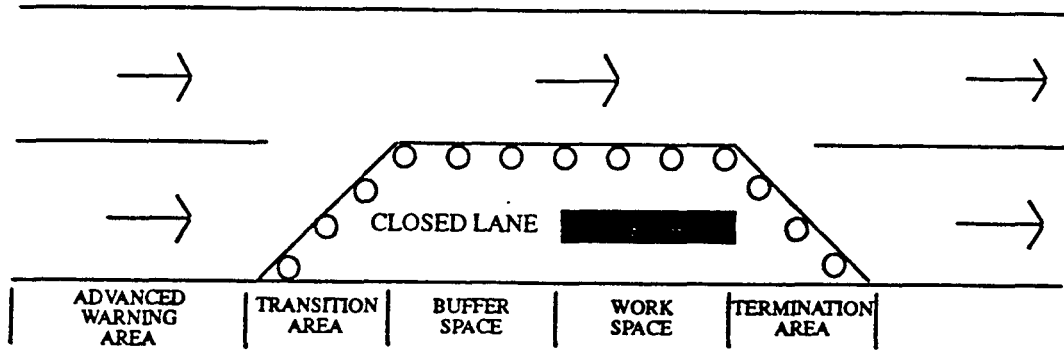
11a. WHAT DO YOU THINK ABOUT THE SPEED LIMIT OF 55 MPH IN WORK ZONES?

- A. *Too slow*
- B. *Too fast*
- C. *About right*
- D. *No opinion*

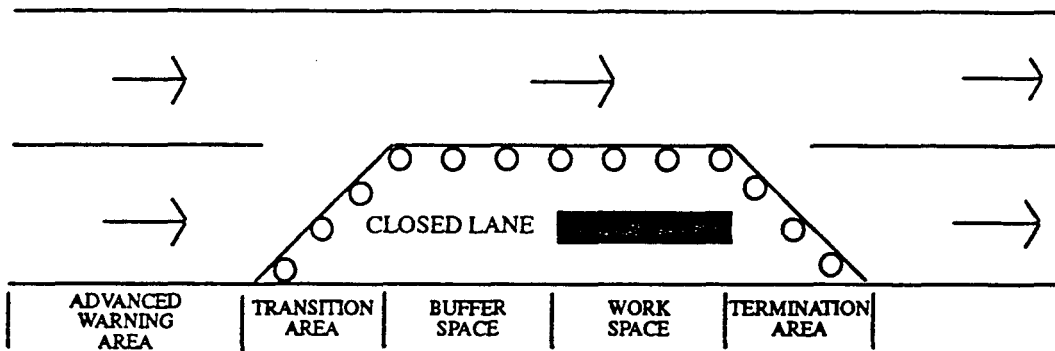
11b. IN A WORK ZONE WITH A 45 MPH SPEED LIMIT, HOW FAST DO YOU USUALLY DRIVE?

- A. *Below 45 mph*
- B. *At 45 mph*
- C. *46-50 mph*
- D. *51-55 mph*
- E. *56-60 mph*
- F. *Over 60 mph*

12. IF YOU HAVE EXPERIENCED ANY BAD DRIVING SITUATIONS IN WORK ZONES, MARK IN THE FOLLOWING SKETCH THEIR LOCATIONS (PUT AN "X" FOR EACH).



13. IF YOU HAVE HAD ANY ACCIDENTS IN WORK ZONES, MARK IN THE FOLLOWING SKETCH THEIR LOCATIONS (PUT AN "X" FOR EACH ACCIDENT).



- 14a. WHAT DO YOU THINK ABOUT THE VISIBILITY OF THE FLAGGERS IN WORK ZONES?

- A. *Flaggers are very visible*
- B. *Flaggers' visibility is okay*
- C. *Flaggers are hard to see*
- D. *No opinion*

- 14b. WHAT DO YOU THINK ABOUT THE DIRECTIONS GIVEN BY FLAGGERS IN WORK ZONES?

- A. *Directions are usually clear*
- B. *Sometimes directions are confusing*
- C. *Most of the time directions are confusing*
- D. *No opinion*

17b. WHAT DO YOU THINK ABOUT THE BRIGHTNESS OF CHANGEABLE MESSAGE BOARDS IN WORK ZONES?

- A. *Too bright*
- B. *Not bright enough*
- C. *Brightness is okay*
- D. *No opinion*

18. ARE THERE ANY UNCLEAR OR CONFUSING SIGNS IN ILLINOIS WORK ZONES?

- A. *No*
- B. *Yes – Unclear (specify):* _____

Confusing (specify): _____

19. SHOULD WE ADD ANY SIGNS OR MESSAGES TO WORK ZONES?

- A. *No*
- B. *Yes Please specify:* _____

20. TODAY, DID YOU DRIVE THROUGH A WORK ZONE IN ILLINOIS?

- A. *Yes*
- B. *No*
- C. *I don't remember*

21. HOW CAN WE MAKE DRIVING THROUGH WORK ZONES BETTER FOR YOU?

Please specify: _____

22. ANY OTHER COMMENTS YOU WOULD LIKE TO MAKE?

THANK YOU FOR YOUR COOPERATION