Fatal and Injury Crash Characteristics in Highway Work Zones

Yingfeng Li, Ph.D.
Assistant Research Scientist (Formerly Ph.D. Student at KU)
Infrastructure Management Program
Texas Transportation Institute
Texas A&M University System
3500 NW Loop 410, Suite 315
San Antonio, TX 78229
Tel: (785) 864-2991
Fax: (785) 864-5631

Yong Bai, Ph.D., P.E.
Assistant Professor
Department of Civil, Environmental, and Architectural Engineering
University of Kansas
1530 W. 15th Street, 2150 Learned Hall
Lawrence, KS 66045
Tel: (785) 864-2991
Fax: (785) 864-5631
E-mail: ybai@ku.edu
(Corresponding Author)

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ABSTRACT

Highway work zone safety has been a research focus for decades. Regardless of the research efforts devoted, highway work zones remain a serious safety concern for government agencies, legislatures, the highway industry, and the traveling public. In this study, the fatal and injury crashes between 1992 and 2004 in Kansas highway work zones were examined systematically and their major characteristics were compared. In addition to the similar characteristics, the comparison showed significant differences between fatal and injury crashes. The researchers found that: 1) head-on was the dominant type for fatal crashes while rear-end was the dominant injury crash type; 2) a large percent of fatal crashes involved trucks while a majority of injury crashes involved light-duty vehicles only; 3) disregarded traffic control, alcohol impairment, and speeding caused a much larger proportion of fatal crashes while followed too close caused a much higher percentage of injury crashes; and 4) unfavorable light conditions and complicated road geometries contributed to a larger percentage of fatal crashes. Based on the study results, safety countermeasures that focus on mitigating the severity of work zone crashes were recommended in terms of work zone traffic control and public education.

INTRODUCTION

The continuously increasing number of highway work zones has created an inevitable disruption of regular traffic flows and has resulted in traffic safety problems. This safety concern was emphasized in the recent Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). Other concerned organizations and researchers have launched a campaign to improve the safety by conducting practical research on various work zone safety-related issues. A significant number of relevant studies have been published to unveil the safety problems and to propose safety improvements in work zones (*1*).

Regardless of these efforts, highway work zone safety remains unsatisfactory (*2*). Although crash rates by vehicle miles traveled (VMT) in work zones are not precisely known, statistics have shown serious traffic safety concerns. In the United States, annual work zone fatalities rose from 872 in 1999 to 1 028 in 2003 (an average of 1 020 per year during this period), adding another 40 000 work zone related injuries per year (*3*). The estimated direct costs of highway work zone crashes were as high as $6.2 billion per year between 1995 and 1997 with an average cost of $3 687 per crash (*4*). The alarming numbers indicate an urgent need for improving work zone safety.

Studying the characteristics of crashes in the work zones is the first step towards the identification of work zone safety deficiencies and potential countermeasures. In addition, investigating the general characteristics and characteristic differences between crashes of different severities (fatal vs. injury) may lead to the discovery of factors causing severity increase, which may benefit the development of traffic controls for reducing the proportion of high-severity crashes in total crashes. This paper presents the results of a characteristic-comparison study between fatal and injury crashes in the work zones. This comparison study provides significant insights for developing effective traffic control strategies that could reduce the number of work zone crashes and mitigate the severity of crashes.

LITERATURE REVIEW

At the beginning of this research, a comprehensive literature review was conducted to synthesize the findings of previous studies on work zone crash characteristics. The predominant work zone crash characteristics from the previous studies are summarized in terms of severity, rate, type, time, location, and causal factors.

Crash Severity. Studies have reached inconsistent conclusions about whether more severe crashes occur in work zones than other highway sections. Some studies from Virginia (*5*), Texas (*6*), Kentucky (*7*), and Ohio (*8*) documented significant increases in severe crashes in work zones. A national study (*9*) also discovered that both fatal crash frequency and average fatalities per crash were higher in work zones across the nation. However, several other studies (*10-12*) did not find significant changes on work zone crash severity. The work zone crashes were even found to be less severe in a few other studies (*13-16*).

Crash Rate. Since highway work zones disrupt regular traffic flows, higher crash rates would be an anticipated outcome. Many studies (*5, 7, 9, 12, 17, 18*) showed higher crash rates in highway work zones. In particular, some studies (*6, 15*) suggested that considerable crash-rate increases could be expected in long-term highway work zones.

Crash Type. The prevailing types of work zone crashes vary with different locations and times, but it was agreed by most of the previous studies that rear-end collision was one of the most frequent work zone crash types (*4, 5, 7, 8, 10, 12-16*). Other major crash types in work zones include same-direction sideswipe collision (*14*) and angle collision (*7*). Some studies ranked hit-fixed-object as another dominant type of work zone crash (*4, 8, 16*). A study in Georgia found that single-vehicle crashes, angle, and head-on collisions were the dominant types of fatal work zone crashes (*19*).

Another major safety concern is the frequent involvement of heavy trucks in work zone crashes. Several studies found that the percentage of truck-involved crashes was much higher in work zones (*7, 9*) and heavy truck related crashes were more likely to involve multiple vehicles and hence frequently resulted in fatalities and large monetary loss (*7, 20, 21*). Benekohal et al. (*22*) found in a survey that 90% of the truck drivers considered that driving through work zones was more hazardous than driving through other areas.

Crash Time. Work zone crashes frequently occur in the daytime during the busiest construction season between June and October (*4, 7, 10, 23*). Nighttime work zone crashes, however, were found to be much more severe in most cases (*5, 7, 9*). Nemeth and Migletz (*8*) found that the proportion of tractor-trailer- or bus- caused crashes at darkness was greater than the proportion of other vehicles, which consequently resulted in more severe crashes due to the large sizes of tractor-trailers and buses.

Crash Location. A national study found that the work zones on rural highways accounted for 69% of all fatal crashes (*9*). In particular, the rural interstate systems or two-lane highways were the places where work zone crashes were most likely to occur (*7, 9, 10, 15*). However, a Virginia study (*5*) argued that, in general, urban highways had much higher percentage of work zone crashes than rural highways.

Causal Factors. Many previous studies pointed at human errors, such as following too close, inattentive driving, and misjudging, as the primary causes for work zone crashes (*4, 7, 10, 16, 20*). Some studies also indicated that speeding (*5*) and inefficient traffic control (*11*) were two other factors causing crashes in work zones. Researchers found that adverse environmental and road surface conditions did not contribute more to work zone crashes than to crashes at other places (*8, 14*).

In summary, work zone crashes have been a research focus for decades and some of the earliest research results were published in 1960s. To date, most work zone crash studies have been conducted statewide and their findings vary with data sources. The researchers did not find any studies that compared the characteristics of fatal and injury crashes in work zones. This comparison could provide new knowledge to develop effective traffic control strategies that can be used not only to reduce the number of work zone crashes but also to mitigate the severity of crashes.

OBJECTIVES AND SCOPE

The primary objectives of this research are: 1) to investigate the characteristics of fatal and injury crashes in highway work zones, 2) to determine the difference between fatal and injury crashes through characteristic comparison, and 3) to recommend safety countermeasures considering the different characteristics between fatal and injury crashes. The scope of this research was limited to the fatal and injury crashes between 1992 and 2004 in Kansas highway work zones.

DATA COLLECTION AND DATA ANALYSIS METHODS

Data Collection

Data for fatal and injury crashes in Kansas highway work zones between 1992 and 2004 was collected from a database. The original data from KDOT’s crash database had a format where a single crash was frequently described in multiple data rows and crash information was recorded using text. This data format could not be directly utilized for analysis using computer software such as SAS. Thus, crash data had to be compiled into a single row per crash in the spreadsheet without missing key information of interest. During this process, text information was also translated into numerical values. In the study period, Kansas work zones had 157 fatal crashes and 4 443 injury crashes. It would be extremely time-consuming yet not statistically meaningful to compile and analyze the entire fatal and injury crashes. Instead, a total of 157 fatal crashes and a sample of 460 injury crashes were selected to save data collection time while still maintaining the reasonable accuracy of analysis results.

The sample size for injury crashes was determined based on the method introduced by Thompson (*24*). Considering that the data would be used for frequency analysis of characteristics reflected through the proportions of the different crashes marked by different variable observations, the sample size was determined such that the proportions could be estimated accurately. Based on normal approximation, to obtain a proportion estimator $\hat{p}$ with a probability of at least 1- α of being no farther than *d* (error) from the true population proportion *p*, one would choose a corresponding sample size such that

$$P(|\hat{p} - p| > d) < \alpha \ .$$

According to Thompson (2002), when there is no estimate of *p* available and the population size *N* is large, the following equation can be used to determine the minimum sample size n_{min}:

$$n_{\min} = \frac{1}{(N-1)/Nn_0 + 1/N} \approx \frac{1}{1/n_0 + 1/N},$$

where:

$$n_0 = \frac{z_{\alpha/2}^2 p(1-p)}{d^2} = \frac{0.25 z_{\alpha/2}^2}{d^2}$$

and $z_{\alpha/2}$ is the upper α/2 point of the standard normal distribution.

For multi-proportion estimations, Thompson (*24*) showed that n_0 was equal to 510 when $\alpha = d = 0.05$ and when the population size *N* was large. Given the 4 443 injury crash population from this study, the minimum sample size needed for frequency analysis at 95% confidence level (an error *d* less than 5%) was determined using the above equation as:

$$n_{\min} \approx \frac{1}{1/n_0 + 1/N} = \frac{1}{1/510 + 1/4443} = 457$$

and rounded to 460.

The data collection was conducted in two steps. First, based on KDOT's database, drivers at fault were identified and their characteristics were compiled along with other crash information into spreadsheets where a crash was described in one data row. Then, for the cases with missing or unclear information, the original crash reports, including detailed crash descriptions in text and sketches, were examined to ensure the data accuracy. The collected crash information contained six categories. Each category had several crash variables as listed in Table 1. The observations of these crash variables were assigned unique integers so that the spreadsheet contained only numerical data. For instance, 0 and 1 were assigned to the variable of gender to represent male and female, respectively.

TABLE 1 Data Categories and Variables

No.	Category	Variable
1	Driver at Fault	Age
		Gender
2	Time	Time
		Day
		Month
		Year
3	Crash Environment Conditions	Lighting
		Weather
		Road surface
4	Road Conditions	Surface type
		Lane number
		Road class
		Speed limit
		Area information
		Road character
		Road special feature
5	Crash Scene Information	Crash location
		No. of cars in collision
		Vehicle maneuver before crash
		Crash type
		Vehicle type
		Traffic control device
6	Other Contributing Factors	Driver
		Pedestrian
		Environment
		Vehicle

Data Analysis Methods

The fatal and injury crashes in the highway work zones were first analyzed separately to identify their respective characteristics. Then, the researchers compared the characteristics between fatal and injury crashes. The focus of this paper is to present the characteristic comparison between fatal and injury crashes. For both types of the crash, frequency analysis was utilized to discover the basic characteristics based on single-variable frequencies and the more complicated characteristics based on cross-categorized multi-variable frequencies. The variable combinations were identified through statistical independence test methods such as Pearson Chi-Square Test and Likelihood-Ratio (LR) Chi-Square Test. The former is a more robust test of independence for small samples. On the other hand, the LR Chi-Square is more appropriate for use in hierarchical models (*25*). Regardless of the different advantages, they were both adopted to avoid missing potential interrelated variable pairs.

COMPARING CHARACTERISTICS OF FATAL AND INJURY CRASHES

The collected fatal and injury crash data were analyzed and their characteristics were compared. The different characteristics of the two types of crash were determined and similar characteristics were also outlined. These results are valuable for the thorough understanding of the general characteristics of fatal vs. injury crashes as well as the unique characteristics distinguishing different crash severities. The comparison also unveiled some important factors that might contribute to a more severe crash. Note that the comparisons were based on percent frequencies of the crashes because only a sample of 460 injury crashes was analyzed. In addition, comparing on a percentage basis instead of absolute numbers would avoid the important characteristics of fatal crashes being overwhelmed by those of the injury crashes that had the much larger number. Table 2 lists the most frequent observations for both fatal and injury crash variables. The comparison results are presented in terms of driver, time information, climatic environment, crash information, road condition, and contributing factor.

TABLE 2 Most Frequent Observations for Fatal and Injury Crash Variables

Variable	Most Frequent Observations	
	Fatal Crash	Injury Crash
Information of Drivers at Fault		
Gender	Male (75%)	Male (66%)
Age	35 – 44 (24%)	15 – 24 (33%)
Crash Time Information		
Time	8:00pm – 6:00am (37%)	10:00am – 4:00pm (42%)
Day	Saturday (17%)	Friday (18%)
Month	June (14%)	August (15%)
Climatic Environmental Information		
Light Condition	Daylight (53%)	Daylight (75%)
Weather Condition	Good (91%)	Good (87%)
Road Surf. Condition	Dry (88%)	Dry (84%)
Crash Information		
Vehicle Maneuver	Following road (74%)	Following road (68%)
Crash Type	Head-on (24%)	Rear-end (46%)
Vehicle Body Type	Truck-vehicle (34%)	Vehicle-vehicle (58%)
No. of Vehicles	Two (53%)	Two (50%)
Road Conditions		
Road Class	Other principle arterials (56%)	Other principal arterials (40%)
Road Character	Straight & level (51%)	Straight & level (66%)
Number of Lanes	Two-lane (63%)	Four-lane (49%)
Speed Limit (mph)	51 – 60 (47%)	51 – 60 (47%)
Crash Location	Non-intersection (67%)	Non-intersection (58%)
Surface Type	Asphalt (69%)	Asphalt (61%)
Road Special Feature	None (85%)	None (85%)
Area Information	Rural (84%)	Rural (86%)
Traffic Control	Center/edge lines (80%)	Center/edge lines (72%)
Contributing Factor		
Driver Factor	Inattention (53%)	Inattention (51%)
Pedestrian Factor	Illegal in road (2%)	--
Environment Factor	Rain, mist, or drizzle (2%)	Rain, mist, or drizzle (2%)
Vehicle Factor	Tires (1%)	Brakes/tires (1%)

Information of Drivers at Fault

Male drivers caused the majority of both fatal and injury crashes in Kansas work zones. Young drivers between 15 – 24 years of age were the driver group frequently involved in the severe crashes. In particular, teenage drivers between 15 – 19 years of age caused 16% of the work zone injury crashes, a percentage that was triple of the percentage of this driver group in the total nationwide driver population (*26*). Among the injury crashes caused by teenage drivers, male teenagers were responsible for 94%. Frequency analyses based on Chi-Square Tests showed that male drivers also caused a higher proportion of single-vehicle injury crashes than multi-vehicle injury crashes. In addition, 55% of the light-duty vehicle injury crashes were caused by drivers younger than 35. The term “light-duty vehicle” refers to the vehicle types including passenger car, van, pickup truck, sport utility vehicle (SUV), all terrain vehicle (ATV), and camper or recreational vehicle (RV). The majority of nighttime crashes were caused by drivers younger than 55 years of age.

Characteristic comparisons showed that the percentage of male drivers responsible for the fatal crashes was higher than that for the injury crashes by 9% (75% vs. 66% as shown in Table 2). Figure 1 illustrates the fatal and injury crash distributions over driver age. Drivers younger than 34 years of age caused a higher percentage of injury crashes than fatal crashes. The drivers aged 35 to 44 caused the highest percentage (24%) of the fatal crashes among all the age groups, which was 9% higher than the injury crashes caused by the same age group. Senior drivers (65 or older) were found to be responsible for a much larger proportion of fatal crashes than for injury crashes.

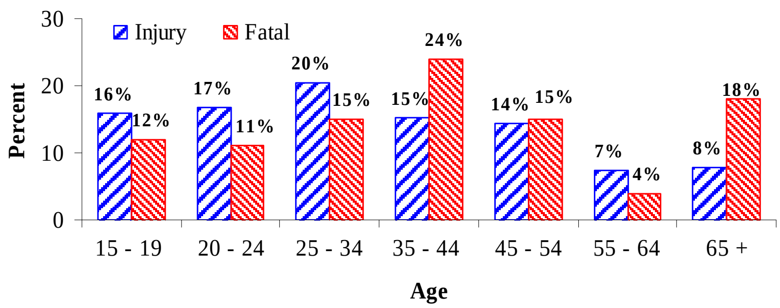

FIGURE 1 Fatal and injury crash percent frequencies by age.

Time Information

As seen from Figure 2, daytime non-peak hours (10:00 a.m. - 4:00 p.m.) had the highest injury crash frequency and the second highest fatal crash frequency (42% and 32%, respectively). A large percentage of the fatal crashes occurred in nighttime between 8:00 p.m. and 6:00 a.m., 19% more (37% vs. 18%) than injury crashes in this time period. Chi-Square Tests indicated that multi-vehicle injury crashes frequently occurred during daytime non-peak hours. When comparing days, the lowest injury crash frequency was observed on Sundays while no significant differences in percentages of fatal crashes were found among days of a week. The majority of both fatal and injury crashes occurred in the busy construction season from April to November.

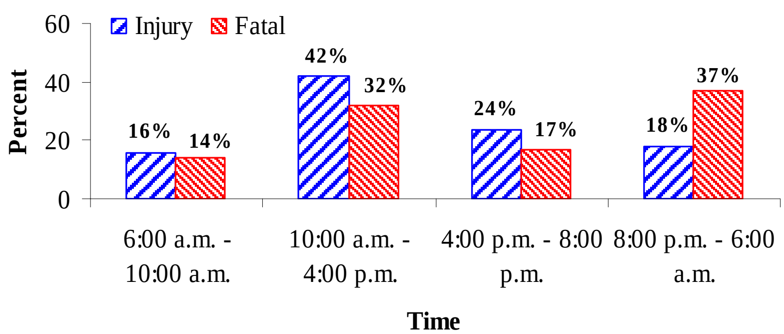

FIGURE 2 Fatal and injury crash percent frequencies by crash time.

Climatic Environment
The study found that an overwhelming proportion of both the fatal and injury crashes occurred when weather and road surface conditions were favorable. Poor light conditions such as dust, dawn, and dark with or without street lights contributed to a considerably larger proportion of fatal crashes than to injury crashes (47% vs. 25%). In particular, 32% of the fatal crashes occurred in darkness without streetlights, while this unfavorable light condition only contributed to 13% of the injury crashes. This significant difference indicated that the poor light condition was one of the causes leading to fatal work zone crashes. The fatal and injury crash frequencies by light conditions are illustrated in Figure 3.

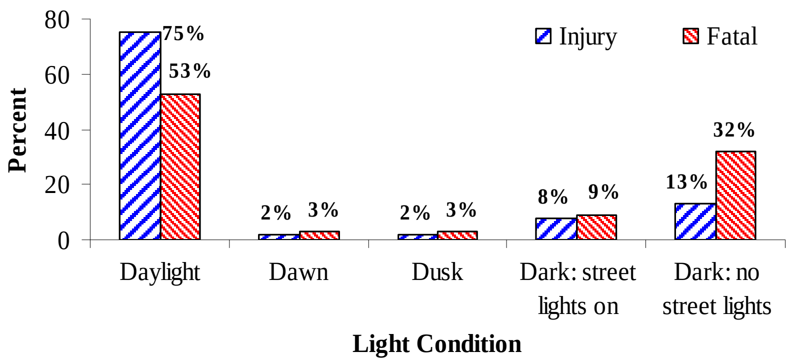

FIGURE 3 Fatal and injury crash percent frequencies by light conditions.

Crash Information
Crash information indicated that before a severe crash occurred, most vehicles at fault were straight following roads. Multi-vehicle crashes were dominant for both fatal (68%) and injury (70%) crashes in Kansas work zones. As seen in Figure 4, among multi-vehicle collisions, head-on was the dominant type for fatal crashes, followed by angle-side impact and rear-end. Rear-end collisions were the dominant injury crash type, followed by angle-side impact collisions and fixed-object collisions. The dominance of rear-end collisions in the injury crashes suggests that relatively high speed combined with following too close was a contributing factor for the injury crashes. In addition, the large percentage of head-on collisions in the fatal crashes indicates that there is a need to install median separators in work zones.

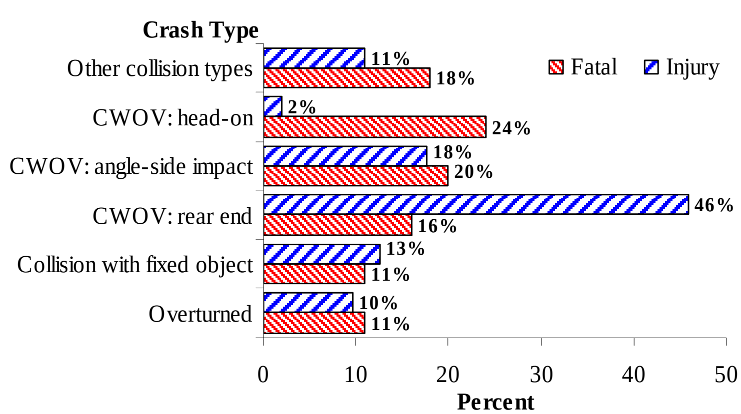

FIGURE 4 Fatal and injury crash percent frequencies by crash type.
(CWOV: collision with other vehicles)

Analyses showed that most (82%) injury crashes involved only light-duty vehicles. On the contrary, about 40% of the fatal crashes involved heavy trucks and almost all of these crashes were multi-vehicle crashes. The term "truck" here refers to the heavy vehicle types such as single large truck, truck and trailer, tractor-trailer, and buses. These results imply that truck involvement could increase the severity of work zone crashes.

Road Condition

A dominant proportion of both fatal and injury crashes took place in work zones on interstate highways and other principal arterials which is shown in Figure 5. Most of the fatal and injury crashes were in rural areas within 51 – 70 mph (82 – 113 km/h) speed zones. Statistical tests indicated that almost half of the single-vehicle fatal and injury crashes occurred on interstate highways and one third of the multi-vehicle fatal and injury crashes occurred in intersections or intersection-related areas.

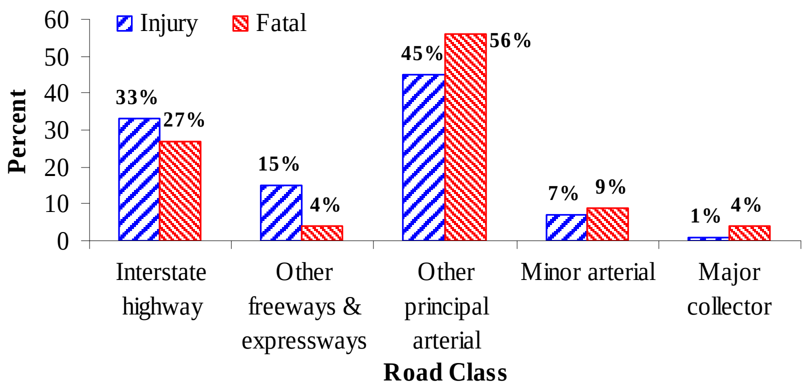

FIGURE 5 Fatal and injury crash percent frequencies by road class.

Compared with fatal crashes, injury crashes were more likely to occur on multi-lane highways, especially on four-lane highways. Data analyses showed that 63% of the work zone fatal crashes occurred on two-lane highways while 77% of the injury crashes were on highways with multiple lanes in each direction. Combining the findings discussed earlier that the most common crash type for the injury crashes was rear-end while head-on was the most common for fatal crashes, this difference suggests that injury crashes were more attributed to high traffic volumes than fatal crashes.

The fatal and injury crash distributions over speed limits had practical differences worthy of discussion. As shown in Figure 6, 51 – 60 mph (82 – 97 km/h) speed zones had the highest proportion of both fatal and injury crashes. With decreasing speed limits, there was a larger percentage of injury crashes. On the other side, with increasing speed limits, there was a larger percentage of fatal crashes occurred on highways with high speed limits between 61 – 70 mph (98 – 113 km/h). This tendency confirmed that high speeds contributed to the increase of crash severity in the work zones.

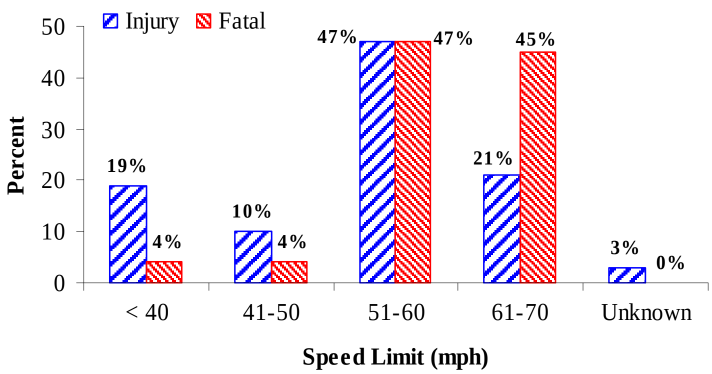

FIGURE 6 Fatal and injury crash percent frequencies by speed limit.

In terms of road characteristics, 66% of the injury crashes occurred in work zones on straight and level highway sections and only 34% of the injury crashes were on highway sections with complicated geometric-alignment features such as grades, curvatures, and hillcrests. Almost half (49%) of the fatal crashes, however, were in work zones on highway sections with complex alignments. In particular, among the complex alignments, straight on grade contributed to the highest proportion of both injury crashes (18%) and fatal crashes (25%). Therefore, the presence of complicated highway alignment features, especially grades, could potentially increase the severity of crashes in the work zones.

Contributing Factor

Inattentive driving contributed to more than half of both fatal and injury crashes. Followed too closely caused 14% more injury crashes than fatal crashes (18% vs. 4%). On the other hand, some other driver errors such as "disregarded traffic signs, signals, or markings" and "under influence of alcohol" resulted in notably higher percentages of fatal crashes than injury crashes. The crash frequencies by major driver errors are presented in Figure 7.

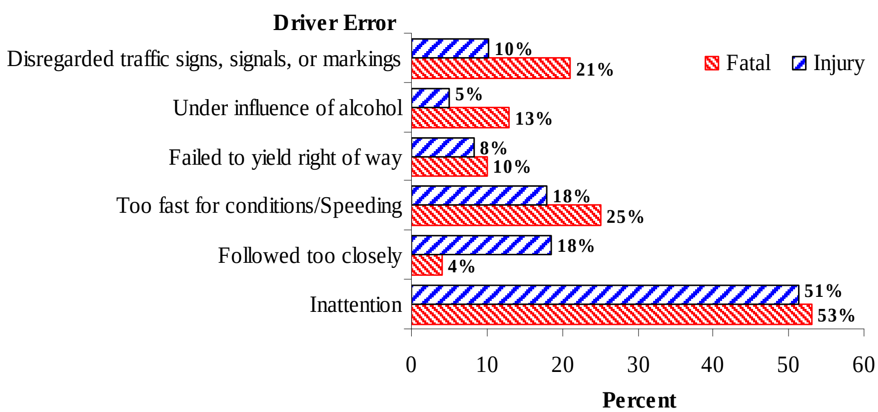

FIGURE 7 Fatal and injury crash percent frequencies by driver error.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The characteristics of fatal and injury crashes in Kansas work zones were investigated systematically utilizing statistical techniques such as frequency analysis and tests of independence. Significantly different characteristics between the two types of the crashes were identified as well in an effort to discover the factors that contributed to the increase of crash severity. The results also provide practical insights to facilitate the development of work zone traffic control strategies that could not only reduce the number of crashes but also mitigate the crash severity.

Summarized in Table 3 are the major general characteristics of fatal and injury crashes in Kansas highway work zones. The comparison study further discovered a variety of differences in characteristics between fatal and injury crashes. Major differences are summarized in Table 4. These characteristic differences were discovered in the aspects including drivers at fault, crash time, crash location, crash type, and causal factors. The researchers found that complicated geometric highway alignments (especially grades), unfavorable light conditions, involvement of heavy vehicles, alcohol impairment, and disregarding traffic control, were potential factors that contributed to the increase of crash severity in work zones. Comparison results also suggested that the fatal crashes were more related to high speeds while the injury crashes were more related to high traffic volumes.

TABLE 3 General Characteristics of Fatal and Injury Crashes

Category	Comparable Characteristics
At-fault drivers	1. Male drivers caused most of the crashes. 2. Male drivers caused most of the truck-involved crashes and single-vehicle crashes.
Crash time	1. Both types of crashes had the highest frequencies during daytime non-peak hours (10:00 a.m. – 4:00 p.m.). 2. Most of the crashes occurred in the construction season from April to November.
Crash location	1. A majority of the crashes occurred on rural highways. 2. Most of the crashes took place on interstates and other principal arterials. 3. Most of the crashes occurred in non-intersection areas without the impacts of road special features such as bridges, interchanges, or ramps.
Crash type	1. Multi-vehicle crashes were the most common type for the crashes. 2. Most truck-involved crashes were multi-vehicle crashes.
Causal factors	1. Human errors, inattentive driving in particular, were the primary causal factors for the crashes. 2. Poor light conditions were a contributing factor for the crashes. 3. Adverse weather conditions, poor road surface conditions, pedestrian factors, and vehicle problems were not important contributing factors for the crashes.

TABLE 4 Major Characteristic Differences between Fatal and Injury Crashes

Category	Fatal Crash Characteristics	Injury Crash Characteristics
Drivers at fault	Drivers between 35-44 and older than 64 frequently caused more fatal crashes.	Drivers younger than 35, especially those between 15-24, frequently caused injury crashes.
Crash time	A much larger proportion occurred during nighttime.	Daytime non-peak hours had the highest crash frequency.
Crash location	Most crashes took place in 51-60 mph (82-97 km/h) and 61-70 mph (98-113 km/h) speed zones.	51-60 mph (82-97 km/h) speed zones had almost half of the crashes; the rest were relatively evenly distributed in other speed zones.
Crash type	Head-on was the dominant type.	Rear-end was the dominant type.
	A large percent of crashes involved trucks.	A majority of crashes involved only light-duty vehicles.
Causal factors	Disregarded traffic control, alcohol impairment, and speeding caused a much larger proportion.	Followed too close caused a much higher percent.
	Unfavorable light conditions, especially nighttime darkness, contributed to a larger proportion.	A majority occurred when light conditions were favorable.
	Complicated road geometries contributed to a larger proportion.	A majority occurred on straight and level highways.

Recommendations

Improvement of traffic control is the most direct method to reduce highway work zone crashes. More effective and sufficient work zone traffic controls should be installed. In particular, there is an urgent need to develop speed control methods that can be strictly enforced in the work zones. Illumination or highly retroreflective devices should be installed in the work zones that stay set up at night. Devices such as transverse markings or temporary raised pavement markers in the advance warning areas may be used to alert inattentive travelers of the upcoming work zones. Installation of median separators is necessary in some work zones with high risk of head-on crashes. Lower speed limits should be considered in work zones with complex highway geometric alignments. Special traffic control strategies need to be developed to guide trucks passing the work zones.

Male teenage drivers and drivers younger than 35 years of age frequently caused work zone injury crashes. Drivers aged 35 to 44 and older than 64 were the groups with the highest fatal crash rate in Kansas work zones. Truck drivers also create serious safety problems in work zones. The authors suggest the launch of driver -oriented education programs in order to raise awareness on highway work zone hazards. The fact that a major cause of most crashes was human errors also indicates the urgency for developing effective training programs to educate the traveling public.

In addition, some sections of the State of Kansas Motor Vehicle Crash Report need to be modified to better facilitate work zone crash investigation. For instance, the traffic control devices listed on the report do not include temporary traffic control devices such as channelizing devices and temporary lighting devices that are commonly used in work zones. As a result, crash investigators (police) usually either classify those temporary work zone traffic control devices as "other" or do not record them. Revisions might also be considered for other sections such as pedestrian identification (regular pedestrian or construction worker), and detailed crash locations within work zones (advance warning area, transition area, activity area, or termination area).

Descriptions of the work zone including the construction work types and construction activities at the crash scene should be also included in the crash reports.

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