Analysis of Work Zone Crash Reports to Determine Factors Associated With Crash Severity

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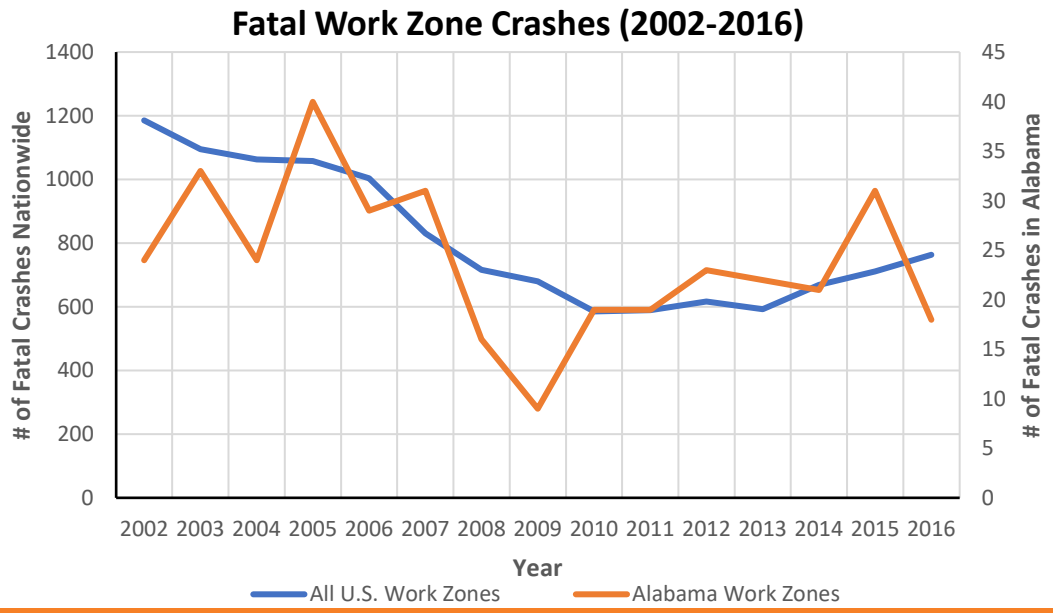
INTRODUCTION

- Work zones are commonplace and present an environment favorable for severe but preventable crashes
- Fatal work zone crashes accounted for 2.7% of all fatalities on Alabama highways in 2015, which was 40% higher than the national proportion (ALDOT 2016; NHTSA 2016)
- The factors influencing work zone crash severity are not well-understood despite substantial research efforts



LITERATURE REVIEW

- Focus areas, methods, and findings vary greatly among past studies
- Generally agreed upon that work zones increase crash *frequency* and that most work zone crashes occur within the activity area (Garber and Zhao 2001; Yang et al. 2014)
- No common thread among factors that influence work zone crash *severity* (Akepati et al. 2011; Ozturk et al. 2015)
- Lack of detailed, useful work zone crash data (Dissanayake and Dias 2015; NCHRP Report 627; ATSSA 2013)

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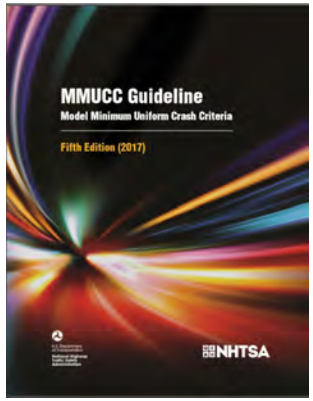
LITERATURE REVIEW

- The Model Minimum Uniform Crash Criteria (NHTSA 2017) defines a work zone-related crash as “in or related to a construction zone…whether or not workers were actually present…even if the first harmful event occurred before the first warning sign”

- Despite this, only 39% of crashes in the study database were marked as work zone-related by attending law enforcement officers



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RESEARCH OBJECTIVES

- Develop a multi-year work zone crash database using traffic crash reports and ALDOT project inspector reports
- Determine factors associated with work zone crash severity and quantify their significance using frequency distribution and regression analysis
- Provide recommendations for improving work zone design, operations, and crash reporting practices
- Suggest topics for future research using this database and others

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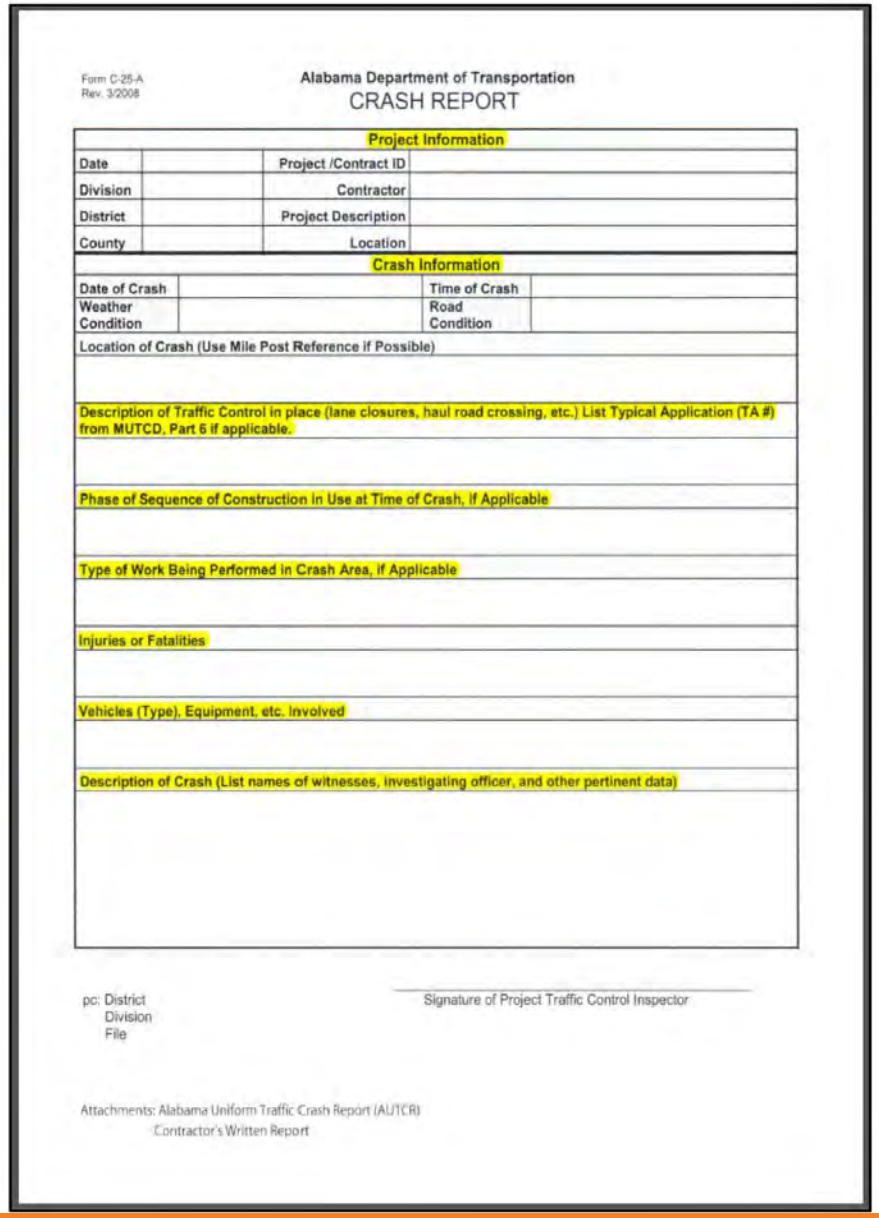
DATA COLLECTION AND MANAGEMENT

- 5,410 hardcopy crash records were scanned and manually entered into a spreadsheet from three main sources:
  - Alabama Uniform Traffic Crash Reports
  - Contractor Letters to ALDOT
  - ALDOT Traffic Control Inspector Reports (Form C-25A)

DATA COLLECTION AND MANAGEMENT



Form C-25A
Rev. 3/2008

Alabama Department of Transportation
CRASH REPORT

Project Information			
Date		Project /Contract ID	
Division		Contractor	
District		Project Description	
County		Location	

Crash Information			
Date of Crash		Time of Crash	
Weather Condition		Road Condition	

Location of Crash (Use Mile Post Reference if Possible)

Description of Traffic Control in place (lane closures, haul road crossing, etc.) List Typical Application (TA #) from MUTCD, Part 6 if applicable.

Phase of Sequence of Construction in Use at Time of Crash, if Applicable

Type of Work Being Performed in Crash Area, if Applicable

Injuries or Fatalities

Vehicles (Type), Equipment, etc. Involved

Description of Crash (List names of witnesses, investigating officer, and other pertinent data)

pc: District
Division
File

Signature of Project Traffic Control Inspector

Attachments: Alabama Uniform Traffic Crash Report (AUTCR)
Contractor's Written Report

Form C-25A

- Completed even for crashes not marked as work zone-related by law enforcement officers
- Contains information related to traffic control in place, worker involvement, and construction equipment involvement
- Used to verify and supplement information from traffic crash reports

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DATA COLLECTION AND MANAGEMENT

- Each crash record (row) was described by 152 data fields (columns)

- These fields were evaluated to determine which were irrelevant or had multiple categories that could be collapsed

Independent Variables Considered in Model Development

Variable No.	Variable Group	Variable Name
1	*Temporal Characteristics*	Time of Day
2		Day of Week
3	*Environmental Characteristics*	~~Light~~
4		Weather
5		Locale
6	*Roadway Characteristics*	Highway Classification
7		~~Highway Side~~
8		Traffic Control
9		Trafficway Lanes
10		~~Roadway Condition~~
11	*Crash Characteristics*	Primary Contributing Factor
12		First Harmful Event
13		~~First Harmful Event Location~~
14		Manner of Crash
15	*Work Zone Characteristics*	Work Zone Relationship
16		Work Zone Type

- 16 variables initially retained

- 12 variables used in final model

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METHODOLOGY

- Crash severity is described by the KABCO scale:

  K = Fatal
  A = Incapacitating Injury
  B = Non-incapacitating Injury
  C = Possible Injury
  O = Property Damage Only

- An ordered probit regression model was found appropriate and processed in SPSS Statistics

FINDINGS

- 25 categories from 11 of 12 modeled variables found significant at $\alpha = 0.05$
- *Work Zone Relationship* (i.e. location within work zone) was the only variable with no significant categories
- Crash characteristics such as *Primary Contributing Factor, First Harmful Event,* and *Manner of Crash* had the strongest influence on crash severity in the database
- Speed may be an underlying factor influencing the significance of several other variables

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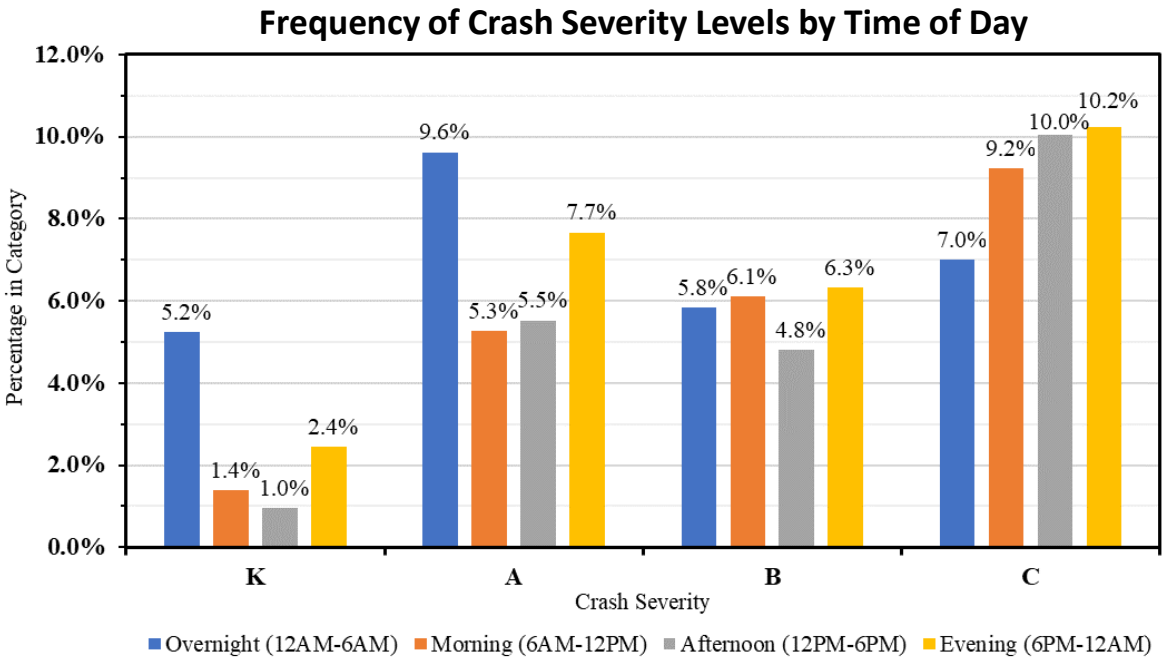
Temporal Characteristics

Parameter		Coefficient	t-statistic	p-value
γ_1 (Threshold 1)		1.174	30.976	< 0.001
γ_2 (Threshold 2)		1.600	39.604	< 0.001
γ_3 (Threshold 3)		1.966	44.580	< 0.001
γ_4 (Threshold 4)		2.847	44.905	< 0.001
Temporal Characteristics	*Time of Day:* Overnight	0.190	2.473	0.013
	Time of Day: Evening	0.146	2.928	0.003



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Environmental Characteristics

Parameter		Coefficient	t-statistic	p-value
γ_1 (Threshold 1)		1.174	30.976	< 0.001
γ_2 (Threshold 2)		1.600	39.604	< 0.001
γ_3 (Threshold 3)		1.966	44.580	< 0.001
γ_4 (Threshold 4)		2.847	44.905	< 0.001
Environmental Characteristics	*Locale:* Open Country	0.188	4.687	< 0.001
	Weather: Rain	-0.196	-3.234	0.001

- *Open Country* (i.e. rural) locales increase the risk of severe work zone crashes
  - Speed limits are higher and drivers less likely to expect work zones in rural areas
- During *Rain*, severe work zone crashes are less likely
  - Drivers are more cautious during adverse weather conditions and work zones are less likely to be operational

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Roadway Characteristics

Parameter		Coefficient	t-statistic	p-value
γ_1 (Threshold 1)		1.174	30.976	< 0.001
γ_2 (Threshold 2)		1.600	39.604	< 0.001
γ_3 (Threshold 3)		1.966	44.580	< 0.001
γ_4 (Threshold 4)		2.847	44.905	< 0.001
Roadway Characteristics	*Traffic Control:* No Passing Zone	0.677	5.609	< 0.001
	Highway Classification: Federal	0.365	7.249	< 0.001
	Highway Classification: State	0.199	3.545	< 0.001
	Trafficway Lanes: Two	0.162	3.277	0.001

- In Alabama, 62% of all *Federal* and *State* route lane-miles are classified as rural (FHWA 2016)
- In 2015, 48% of all fatalities nationwide occurred on rural facilities, which had a fatality rate 2.6 times greater than those in urban areas (NHTSA 2016)
- In 2015, 16.1% of all fatal work zone crashes in Alabama occurred in no-passing zones (ALDOT 2015)

Crash Characteristics

Parameter		Coefficient	t-statistic	p-value
γ_1 (Threshold 1)		1.174	30.976	< 0.001
γ_2 (Threshold 2)		1.600	39.604	< 0.001
γ_3 (Threshold 3)		1.966	44.580	< 0.001
γ_4 (Threshold 4)		2.847	44.905	< 0.001
Crash Characteristics	*Manner of Crash:* Head-On	1.430	9.127	< 0.001
	First Harmful Event: Rollover/Jackknife	0.863	6.001	< 0.001
	First Harmful Event: Collision with Bicyclist/Pedestrian	0.574	3.032	0.002
	Manner of Crash: Angle	0.546	10.889	< 0.001
	Manner of Crash: Single Vehicle Crash	0.397	7.089	< 0.001
	Primary Contributing Factor: Excessive Speed	0.281	3.253	0.001

- Crashes involving pedestrians were not frequent (41 records), but were often fatal (17 fatalities)
- Excessive speed had the highest frequency of the above categories (241 records) and lead to fatal or injury crashes 36% of the time
- The significant crash types in the model are typically severe, but especially in Alabama work zones

Work Zone Characteristics

Parameter		Coefficient	t-statistic	p-value
γ_1 (Threshold 1)		1.174	30.976	< 0.001
γ_2 (Threshold 2)		1.600	39.604	< 0.001
γ_3 (Threshold 3)		1.966	44.580	< 0.001
γ_4 (Threshold 4)		2.847	44.905	< 0.001
Work Zone Characteristics	*Work Zone Type:* Work on Shoulder/Median	0.436	2.856	0.004
	Work Zone Type: Lane Shift/Closure	0.316	2.580	0.010

- Work zones involving shoulder/median work or a lane shift/closure had a positive influence on crash severity relative to crashes marked *not applicable*
- Crashes occurring in temporary work zones that involve a change in normal traffic patterns are more likely to be severe

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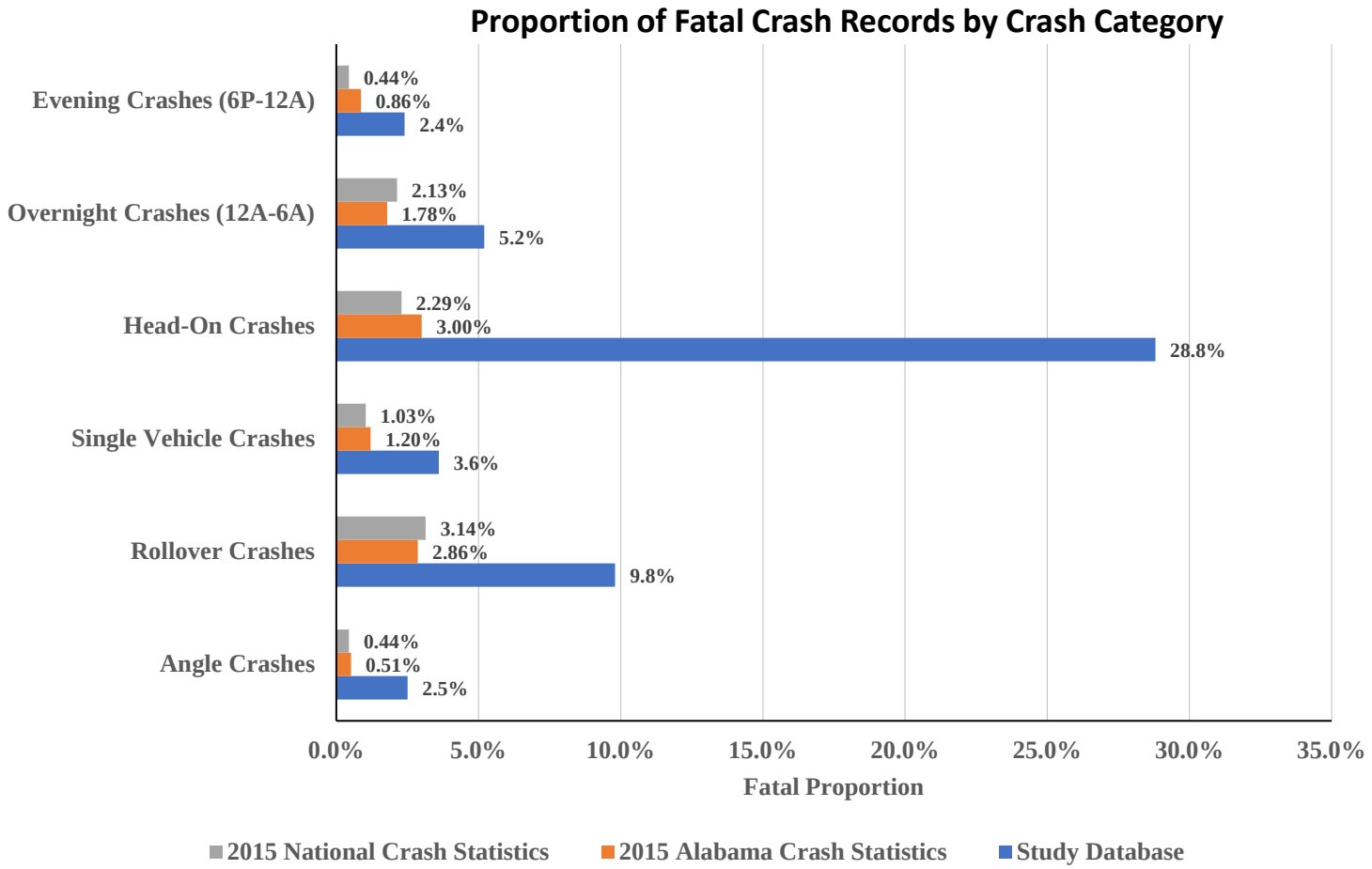
CONCLUSIONS

- The coefficients in the regression model could often be explained by statistical trends that hold true among all highways, but many fatality rates were exaggerated in the study database



STUDY LIMITATIONS

- Due to data cleaning issues and time constraints, supplemental data from form C-25 was not fully utilized
- A *Work Zone Relationship* of *Not in/Related to Work Zone* constituted 60% of the database, so analysis of this variable was limited
- Future research using this database and others should take advantage of information from supplemental reports

RECOMMENDATIONS

- Agencies should be particularly focused on improving design and operation of temporary work zones, especially those occurring in rural areas

- ALDOT and other agencies should work to improve work zone crash reporting policies by:

  - Providing proper training to law enforcement officers
  - Ensuring adequate geographic coverage of reporting
  - Maintaining electronic databases created from the sources used in this study

QUESTIONS?

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