

**STUDENT WORK SAFETY GUIDELINES
IN ROADSIDE APPLICATIONS AND
WORK ZONES**

**Safety Guidelines for
Transportation
Researchers**

Final Report

SPR 304-731



Oregon Department of Transportation

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APPLICATIONS AND WORK ZONES**

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Final Report

SPR 304-731

by

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Abstract Universities, colleges, and other learning institutions regularly conduct research on behalf of state departments of transportation (DOTs). Much of the research involves data collection and testing work by student researchers on roadways and other types of field sites. The field research may require students to work on the roadway, in the right-of-way, or close to live traffic environments. As a result, the working conditions expose the students to safety hazards created by the exposure to passing traffic, surrounding work equipment, work operations, and site conditions. Safety precautions are needed to protect the students from the associated increased risk of injury. In many cases, the students performing the work have little prior experience working on active roadways, and often minimal if any safety training. Formal safety training and the availability of training resources are needed to provide these students with adequate knowledge and skills to ensure that they know how to work safely on roadways when conducting research-related activities. This document aims to provide a resource for safety training to student research assistants and any other personnel who conduct research on roadways near or in traffic. The manual is designed to accompany the video titled "Goal One: A Safe Return Each and Every Day." After reading the manual and watching the video, student researchers will: (1) Understand the likely hazards present in roadway work areas; (2) Know how to prepare for working on roadway work sites; and (3) Know how to conduct their work on roadways safely. DOTs and universities are encouraged to use the manual for training students regarding how to work safely on roadways when performing research.			
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yd	yards	0.914	meters	m	m	meters	1.09	yards	yd
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*SI is the symbol for the International System of Measurement

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EXECUTIVE SUMMARY

Many state departments of transportations (DOTs) contract with universities, colleges, and other learning institutions for research and data collection work. To conduct the research, state DOTs receive funding, in part, from the State Planning and Research (SPR) funds program via the Highway Trust Fund. For many of the research studies, student researchers participate in the research work. Many of the research tasks that students conduct are not technically difficult and may not require specialized skills. However, the research tasks often involve data collection on field sites by both manual and automated means. These jobs are often opportunities for students aspiring to work in the transportation field to gain experience on work sites. However, performing the data collection and operating various research devices may require work on the roadway, in the right-of-way, or close to live traffic environments. Workers present on roadways are exposed to hazardous conditions. Close proximity to high speed traffic and construction equipment are examples of hazards that exist in roadway work. If adequate controls are not in place, workers are at increased risk of injury and death. A variety of controls are regularly utilized to help protect workers on roadway work sites. These include engineering controls, such as concrete barriers, and personal protective equipment such as reflective vests and wearable lights. Administrative controls – those controls that aim to promote and implement safe work operations and procedures – are also commonly utilized. One type of administrative control is safety training. The goals of safety training are to increase the skill level, hazard awareness, and risk perception of workers, and promote best safety practices when conducting work operations.

Safety training is regularly provided for DOT employees, and for roadway construction and maintenance workers by their employers. However, there is a lack of resources for roadside and on-road worker safety training that are specifically targeted at students involved in transportation research. University curricula for engineering students typically do not include roadway worksite safety training. In addition, those students who have the opportunity to participate in transportation research often only receive informal safety training when required to collect data in the field. Formal safety training resources are needed to provide these students, and all future students who enter the transportation industry, with adequate knowledge and skills to ensure that they know how to work safely on roadways.

The goal of this study was to develop safety training resources for student researchers that could be disseminated nationally to state DOTs and universities. The study involved a detailed literature review to identify current safety training resources, a survey of DOTs and roadway construction contractors, and the development of a safety training manual and video, titled “Goal One: A Safe Return Each and Every Day.” After reading the manual and watching the video, student researchers will: (1) Understand the likely hazards present in roadway work areas; (2) Know how to prepare for working on roadway work sites; and (3) Know how to conduct their work on roadways safely. DOTs and universities are encouraged to use these resources for training students regarding how to work safely on roadways when performing research.

1.0 INTRODUCTION

1.1 BACKGROUND

Many state departments of transportations (DOTs) contract with universities, colleges, and other learning institutions for research and data collection work. To conduct the research, state DOTs receive funding, in part, from the State Planning and Research (SPR) funds program via the Highway Trust Fund (National Academies of Sciences 2016). For many of the research studies, student researchers participate in the research work. Many of the research tasks that students conduct are not technically difficult and may not require specialized skills. However, the research tasks often involve data collection on field sites by both manual and automated means. These jobs are often opportunities for students aspiring to work in the transportation field to gain experience on work sites. However, performing the data collection and operating various research devices may require work on the roadway, in the right-of-way, or close to live traffic environments. Workers present on roadways are exposed to hazardous conditions. Close proximity to high speed traffic and construction equipment are examples of hazards that exist in roadway work. If adequate controls are not in place, workers are at increased risk of injury and death. A variety of controls are regularly utilized to help protect workers on roadway work sites. These include engineering controls, such as concrete barriers, and personal protective equipment such as reflective vests and wearable lights. Administrative controls – those controls that aim to promote and implement safe work operations and procedures – are also commonly utilized. One type of administrative control is safety training. The goals of safety training are to increase the skill level, hazard awareness, and risk perception of workers, and promote best safety practices when conducting work operations.

Safety training is regularly provided for DOT employees, and for roadway construction and maintenance workers by their employers (ATSSA 2016; Boston University 2011; Construction Safety Council 2008a). However, there is a lack of resources for roadside and on-road worker safety training that are specifically targeted at students involved in transportation research. University curricula for engineering students typically do not include roadway worksite safety training. In addition, those students who have the opportunity to participate in transportation research often only receive informal safety training when required to collect data in the field. Formal safety training resources are needed to provide these students, and all future students who enter the transportation industry, with adequate knowledge and skills to ensure that they know how to work safely on roadways.

1.2 GOALS AND OBJECTIVES

The overall goal of the research study is to improve the safety of students and other researchers on roadway worksites. To attain this goal, the research study will:

1. Perform a best-practice safety review, focused on data collection and other similar research activities for a student-worker audience in the transportation research field; and
2. Create an outline/manual and produce a video aimed toward student-workers for a national-level audience.

1.3 RESEARCH SCOPE AND METHODS

1.3.1 Documentation of Existing Roadside Worker Safety Training Resources

The study effort begins with a review of relevant safety resources. The researchers identify the “recognized authoritative works” on roadside worker safety and document them in a literature review chapter. It was anticipated that a large amount of material would be found regarding safety practices regarding roadside construction. Sources for best practices for roadside or on-road workers are cited. The literature review contains a summarized list of best practices of the most relevant and recent materials for a focus on students. The researchers review the documents to distill the main content covered in the training and to develop content for the planned training materials to be created as part of subsequent tasks.

In addition, the researchers contact and interview construction contractors to determine the typical information and practices used to train their workers on roadside safety. The researchers needed ODOT Technical Advisory Committee (TAC) approval before releasing the survey. TAC approval was regarding the suggested type of interview (phone vs in-person), estimated duration of the survey, number of questions, wording of questions, audience, number of people to send the survey to, etc. ODOT distributed the survey to DOTs and wanted to coordinate efforts between the different audiences. The interview results were used in conjunction with the literature search materials to guide the development of the training materials and establish a recommended process for training students on roadside and on-road work.

1.3.2 Survey of Current Practice

ODOT distributed the survey through the American Association of State Highway and Transportation Officials (AASHTO) listserv. The AASHTO listserv audience is all state DOTs and US Territories. Prior to the distribution of the survey questionnaire by ODOT, the researchers developed a narrowly focused list of questions that ask about the current DOT practices related to training, the content of any training materials that have been developed, and the recommended practices to train students on roadside safety. The questionnaire was sent to the TAC to pilot test (and approve) before it was distributed to the DOTs. Feedback from the TAC was incorporated into the questionnaire, and a revised questionnaire approved before being sent via e-mail to each DOT. The results of the survey are used to inform the content included in the training materials.

1.3.3 Develop Curriculum Recommendation

This task aimed to summarize and scope the safety training material that needs to be included for a student audience. Using the materials collected from prior tasks, the researchers develop content for safety training documents. It was anticipated that this content will cover such topics as personal protective equipment, worker awareness, pre-task safety planning, worker behavior and actions in a roadside work site, and other relevant safety practices.

1.3.4 Create Video

The data collected from the prior tasks is analyzed to determine materials to structure an outline for a professional-level, national audience video. Based on this outline, the researchers draft a storyboard on student roadside worker safety for viewing by the TAC, students, and others involved in data collection on roadways. The draft includes an outline, a script, learning points to emphasize, and any specific video-shots they may need to illustrate the issues. The TAC then advises and assigns responsibility to TAC members or researchers who will be responsible to recruit actors (including a mix of students, professors, and experienced workers). ODOT Reprographics is employed to create a draft from the storyboard. The researchers and ODOT Reprographics combine efforts to create a draft video for presentation to the TAC. The draft video is reviewed by the TAC. ODOT Reprographics and the research team incorporate the TAC's final edits to create a final video. The final video length was not to exceed 25 minutes and is intended for online distribution (e.g., via YouTube or other internet video player) and ODOT's social media communications efforts. The video will also be delivered in Betamax format (or other acceptable high-quality video format, per the TAC's approval) should the need arise to have a higher quality medium for re-editing, viewing, or other sharing (e.g., media/news program).

1.3.5 Documentation and Dissemination

The researchers prepare and submit a draft final research report to ODOT for review and comment. The draft report presents the findings of the research and provides recommendations to ODOT for implementation in practice. The final video will be presented. Following ODOT's review, the draft final research report is revised based on the comments received from ODOT, and a final research report prepared and submitted to ODOT for publication.

1.4 BENEFITS

The overall benefit of the study will be to promote safety with training materials focused on on-road and roadside work being conducted by student workers. ODOT will benefit by having created a best-practices document focused on safety for a needed, targeted audience. The materials will be used to instruct students participating in ODOT research studies, other students who are interested in working for ODOT, and other transportation organizations, on how to work safely in roadway work sites. ODOT may benefit by distributing these materials to other organizations that also have on-road and roadside workers.

Oregon learning institutions will benefit, via the various Environmental Health and Safety (EH&S) offices at the universities, to have materials to advise students on best practices for on-road and roadside work. The Federal Highway Administration (FHWA) will benefit by having materials and a video to share with other state DOTs and US Territories.

It is anticipated that the overall benefit will be safer work sites and fewer injuries for those who are collecting data and working on Oregon and national roadways.

1.5 IMPLEMENTATION

The product of the study will be a report that describes and contains the learning material (video and training manual) a student should know before going onto a roadside worksite. The learning materials will be distributed by the ODOT Research Office to research teams contracted to perform research for ODOT. This can be implemented through ODOT's contracting process, (e.g., require reading and review by vendors contracted with ODOT who have student workers). ODOT will make the materials public so that they may be used by other state DOTs, state agencies, universities, or private entities that employ students for occasional roadside and right-of-way work.

2.0 LITERATURE REVIEW

Roadway and work zone safety control have been the subject for many research efforts in the past. Among different states within the United States, safety is always the first priority. Various papers, videos, and workbooks have been published to promote roadway safety and construction and maintenance work zone safety by controlling traffic speed and regulating workers' behaviors. Most of the training publications focus on worker safety, and many of those do not address the safety of students on roadways and in work zones.

The goal of this project is to create guidelines for student worker safety while working in transportation work zones. The first step was to perform a review of literature to understand what training material is currently available and used. For the literature review, the references reviewed focus on student and worker safety in transportation work zones. In this chapter, the safety topics included in the references are listed. Vehicle hazards and on-site hazards for transportation work zones are illustrated to identify the risks associated with them. Recommended safety solutions are presented for the identified hazards and risks.

2.1 DATA ON INJURY/FATALITY ACCIDENTS IN OR NEAR WORK ZONES

The Federal Highway Administration (FHWA 2016) publishes facts and statistics on work zone safety. The FHWA website currently presents data at a national level up to 2015. In 2015, there were total 96,626 crashes estimated to have occurred in work zones nationwide. Figure 2.1 shows the estimated number of non-work zone and work zone crashes in the US from 2008 – 2015 (FHWA 2016). The number of crashes varies from year-to-year and has increased in recent years. The issue of preventing accidents from occurring should be one of the main concerns for DOTs.

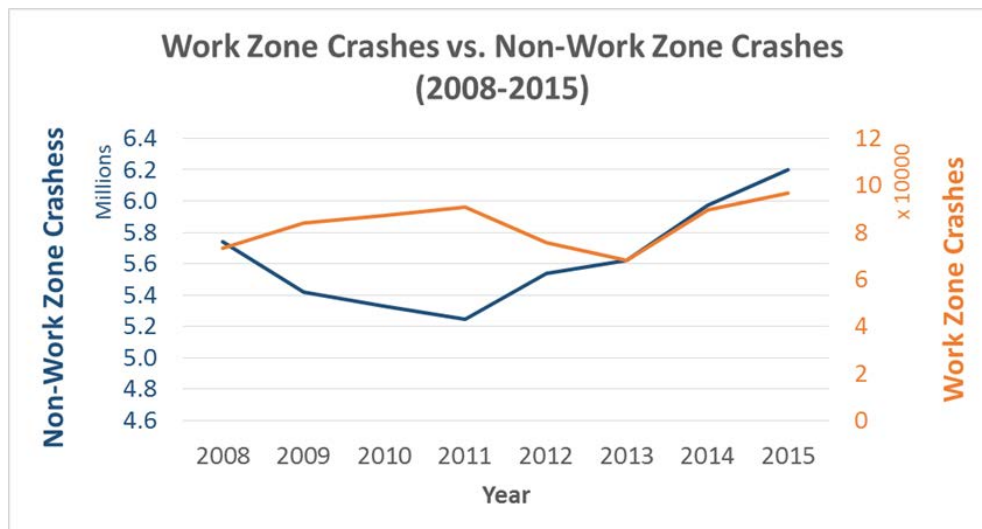


Figure 2.1: National Estimate of Work Zone Crashes (FHWA 2016)

The rate of fatalities in work zones as a result of crashes and total number of fatal crashes are also published by the National Work Zone Safety Information Clearinghouse (workzonesafety.org). The rate is calculated as the number of fatalities in a work zone divided by the total number of fatalities, and expressed as a percentage. Oregon had a rate of 1.12% in 2014 and maintains a relatively low rate compared with other states. The chart shown in Figure 2.2 illustrates the statistics from 2014 for all 50 states in the US.

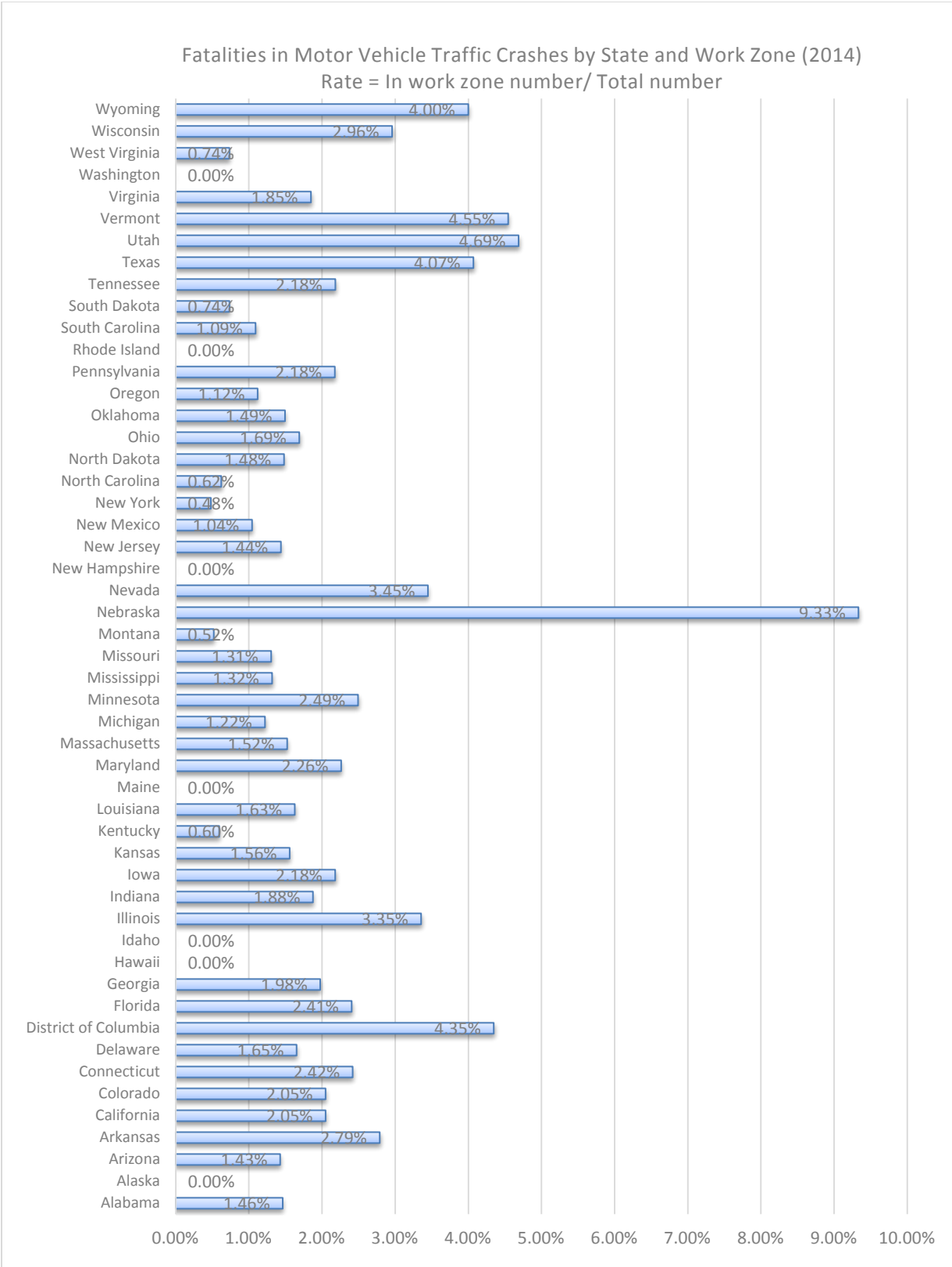


Figure 2.2: Fatalities in Motor Vehicle Traffic Crashes in Work Zones by State (2014)

Safety related to on-site vehicles and equipment is also an important issue for all workers in construction and maintenance work zones, including students. The National Institute for Occupational Safety and Health (NIOSH) oversees the Fatality Assessment and Control Evaluation (FACE) Program which involves detailed investigations of fatal incidents in workplaces. NIOSH FACE reports are published to provide case study examples and recommended safety practices related to the fatality cases. A review of the FACE reports shows those incidents related to fatalities in work zones. Based on the FACE reports from year 2004 to year 2014, a total of 25 incidents involving vehicles were reviewed (Note: not all fatal incidents that occur each year are reviewed by the NIOSH FACE Program). Figure 2.3 highlights all incidents involving vehicle-backing that are recorded in the FACE reports (NIOSH 2016).

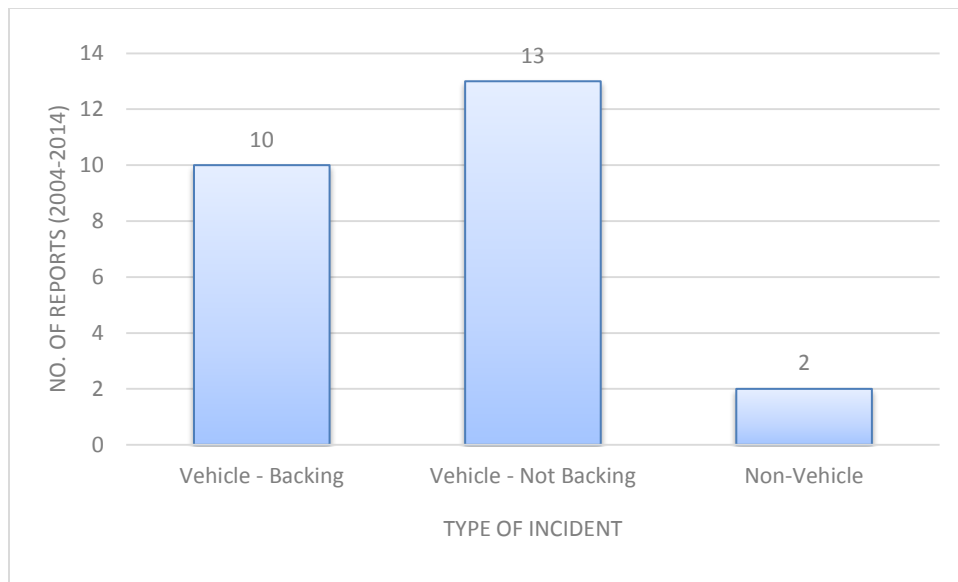


Figure 2.3: Distribution of Highway Work Zone Incidents by Type (NIOSH 2016)

The National Highway Traffic Safety Administration (NHTSA) maintains the Fatality Analysis Reporting System (FARS) database that contains details about fatal crashes on US roadways. A review of the FARS database indicates that the database does not have the option to isolate fatalities that were sustained solely by highway workers (i.e., not including motorists and others). The database does have selections that can limit the data to crashes involving non-occupants, which include highway workers in work zones. In particular, there is a query option for “Non-Motorist Action Circumstances at Time of Crash.” This option can be cross-tabbed with the work zone attribute, to determine if there are any particular action circumstances that lead to fatalities of non-motorists (e.g., workers, students, others) in work zones. Table 2.1 provides a summary of this FARS database showing the non-motorist action circumstances at the time of the crash, in work zones (WZ) and in non-work zones (Non-WZ), from 2011 to 2013 (Gambatese et al. 2017).

Table 2.1: Number of Fatalities based on Non-Motorist Action Circumstances at Time of Crash (Gambatese et al. 2017)

Non-Motorist Action Circumstances at Time of Crash	Non-WZ Fatalities	WZ Fatalities
No Improper Action	1248	44
Dart/Dash	664	8
Failure to Yield Right-Of-Way	1447	16
Failure to Obey Traffic Signs, Signals or Officer	269	1
In Roadway Improperly (Standing, Lying, Working, Playing, etc.)	757	16
Entering/Exiting Parked/Standing Vehicle	27	1
Inattentive (Talking, Eating, Etc.)	119	1
Improper Turn/Merge	40	0
Improper Passing	5	0
Wrong-Way Riding or Walking	117	0
Driving on Wrong Side of Road	15	0
Improper Crossing of Roadway or Intersection (Jaywalking)	727	11
Failing to Have Lights on When Required	11	0
Operating Without Required Equipment	29	0
Improper or Erratic Lane Changing	9	0
Failure to Keep in Proper Lane or Running Off Road	8	0
Making Improper Entry to or Exit From Traffic way	7	0
Operating the Vehicle in other Erratic, Reckless, Careless or Negligent Manner	3	0
Not Visible (Dark clothing, No Lighting, etc.)	824	11
Other	239	8
Not Reported	168	5
Unknown	310	4
TOTAL	7,043	126

The NHTSA FARS data NIOSH FACE reports provide direct oversights of serious roadway work zone safety issues. The safety issues exposed in these databases also provide direction regarding content for a safety training guide for the student workers in roadsides and work zones.

2.2 SUMMARY OF SAFETY TOPICS PRESENT IN LITERATURE

Based on the review of all of the references provided by ODOT in the project work plan and the additional on-line search, the safety topics for transportation worker safety can be divided into two different categories, namely vehicle safety and on-site safety. Vehicle safety topics refer to the safety hazards and potential risks caused by the flowing traffic adjacent the work area. On-site safety topics refer to the safety hazards and potential risks of unsafe on-site conditions and unsafe behaviors of workers on the site, which could include student researchers.

The literature review located a total of 39 resources applicable to the student worker safety topic. The 39 related references that were reviewed for this study are listed in Table 2.2 along with a

brief summary of the content. The specific safety topics covered within each reference are identified in the Appendix.

Table 2.2: Worker Safety Training References and Summary

Ref. No.	Title	Citation	Summary
1	ODOT-2016 Work Zone Fact Sheet	OregonDOT 2016	ODOT published some useful tips for worker safety in construction work zones. It lists some facts and guidelines for workers before entering the work zone area.
2	2011 Oregon Temporary Traffic Control Handbook (For operations of three days or less)	OregonDOT 2011	This handbook includes guidance on temporary traffic control, from general standards and practices, to incident traffic control.
3	Intersection Safety - A manual for local rural road owners	USDOT 2011a	This manual focuses on intersection safety for local rural road owners, and lists some regulations such as placement of the warning signs.
4	Roadway Departure Safety - A manual for local rural road owners	USDOT 2011b	This manual focuses on roadway departure safety for local rural road owners. It identifies some safety issues and describes several case studies.
5	Road Safety Information Analysis - A manual for local rural road owners	USDOT 2011	This manual focuses on road safety for local rural road owners. It mainly addresses data analyzing and case studies.
6	Highway Work Zones and Signs, Signals, and Barricades	OSHA 2016	This website lists all of the safety regulations related to highway work zones and sign, signal, and barricade placements to ensure construction work zone safety.
7	Building Safer Highway Work Zones. Measures to prevent worker injuries from vehicles and equipment	Pratt, Fosbroke and Marsh 2001	Published by NIOSH, this paper mainly discusses the injury prevention measures in highway work zones.
8	OSHA Instruction - Inspection and citation guidance for roadway and highway construction work zones	Michaels 2012	This instruction provides general enforcement policy and guidance to assist OSHA compliance personnel in safely inspecting work sites where employees are engaged in construction work on and near roadways or highways.
9	Manual on Uniform Traffic	USDOT 2009,	This manual presents detailed

	Control Devices for Streets and Highways	revised 2012	information regarding signs, markings, highway traffic signals, and many other traffic control devices that are used to ensure work zone safety.
10	Work Zone Hazards Awareness Workbook	Construction Safety Council 2008a	This workbook illustrates different safe solutions/reactions while exposed to hazardous surroundings and conditions in roadway work zones.
11	ATSSA - Work Zone Safety Grant	ATSSA (no date)	This website lists a series of videos for construction work zone safety training.
12	ATSSA - Guidance Documents	ATSSA (no date)	This website lists safety guidance documents for different kinds of work zones. The guidance documents could be included in safety training.
13	OSU Safety (SAF) Manual	Oregon State University (no date)	Oregon State University provides its own regulations related to general safety, workplace safety, and laboratory safety for faculty, students, and staff. Construction worker safety is also included.
14	Flagger Training	Chemeketa Community College (no date)	Chemeketa Community College offers flagger certification training courses. This website shows the importance of flagger certification.
15	Roadside Worker Safety	Environmental Health and Safety 2011	Boston University (BU) published this roadside worker safety manual to ensure BU employees who are performing work on or in close proximity to roadways are properly equipped with high visibility safety apparel and warning devices, and have the appropriate training and knowledge to properly plan for roadside work.
16	Roadside Safety	WSDOT 2016	Chapter 310 of this manual refers to roadside safety, and describes practices related to the safety of vehicle occupants, workers, and pedestrians.
17	It Can Be a Dangerous Job	OregonDOT 2014	This video shows a police officer who uses his own experience to

			tell the public that roadside work is a dangerous job and remind people to be more careful while driving through work zones.
18	Student Roadside Safety Training	Purdue University, Joint Transportation Research Program 2011	This video shows how student workers should behave while heading out to roadside work zones. The video includes important and useful tips for student workers in construction work zones.
19	Norton Road Construction Work Zone Safety	Norton Construction 2012	Norton Construction Co. published this video to train its workers and employees who are working in roadside work zones to reinforce their safety.
20	Work Zone Safety Traffic Control Devices	PublicResourceOrg 2010a	This video illustrates the placement and operation of different warning signs and traffic control devices.
21	One Step from Death	PublicResourceOrg 2010b	In this video, workers share their stories about accidents they have experienced, encouraging people to be careful while driving through work zones.
22	Roadside Accidents	Towing TV 2012	Contains some posted road accidents captured by road security cameras. Warns the public to be more careful.
23	A Family's Grief - Your Car is Like a Weapon	NYDOT Marketing 2008	Shows a family's grief due to a fatality accident, and encourages drivers to slow down while passing through work zones.
24	Roadworker Safety - Silence is Consent (Parts 1 and 2)	Ihtmidlands 2009	This video aims to persuade workers to report unsafe behavior and conditions as soon as possible. Keeping silent is another form of consent for unsafe situations.
25	Work Zone Safety News - TDOT Workers	Yarman 2011	The video is a recorded TV news broadcast that talks about a roadway fatality accident. The video includes some analysis of the reasons for the accident.
26	Stay Alert Stay Alive - Work Zone Safety 2012	Flagger Force 2012	This video lists several useful safety tips for construction work zone workers.

27	Flagging - Safety Is In Your Hands	ACSA Safety 2012	The video is about flagger training, what should flaggers do, and what should they not do while working in roadside work zones.
28	Worker Safety	USDOT 2015	The Federal Highway Administration created this website to help enforce worker safety. The website includes worker visibility regulations, temporary traffic controls, and training strategies.
29	Work Zone Safety	WisconsinDOT (no date)	This website provides worker safety tips and guidance while working in the field.
30	OSHA Fact Sheet	OSHA 2005	A fact sheet published by OSHA that lists safety guidelines for on-site construction work.
31	Work Zone Traffic Control Guidelines 2013	IndianaDOT 2013	This guideline describes work zone traffic control recommended practices, and separately talks about traffic control in short-term stationary, short duration, and mobile operation situations.
32	Vehicle Backing Safety Factsheet	Texas Department of Insurance (no date)	This factsheet is designed to remind people about the hazards that they should know to safely perform vehicle backing.
33	Drive Sober. The Way to Go.	OregonDOT (no date)	This brochure points out how to spot an impaired driver and the importance of not driving under the influence of alcohol and drugs.
34	Slow Down, the Way to Go.	OregonDOT (no date)	This brochure reminds drivers to slow down while driving. It lists the penalties and potential risks of excessive speed.
35	Respect the Zone. The Way to Go.	OregonDOT 2014	This brochure educates drivers about why fines are doubled within work zones, and why it is important to slow down while passing through work zones.
36	Follow the Signs to Safety	OregonDOT 2008	This brochure provides some infographic content about the signs that appear in construction work zones.
37	Don't be a Flight Risk. Buckle up.	OregonDOT Transportation	This brochure illustrates the importance for drivers and

		Safety 2015	passengers to put on their seat belts while in moving vehicles.
38	Winter Travel Tips and Information	Oregon.gov (no date)	This website points out how drivers should behave when they experience hazardous environmental and roadway conditions during the winter.
39	ODOT Safety Calendar 2016		This calendar provides several safety tips on the cover of each month.

Among those safety topics, most are related to the safety of workers in work zones. After reviewing all of the 39 references, the researchers identified the common safety topics contained within the references. The following topics are included in more than 10 of the reference sources:

- **Wearing high visibility safety apparel:** ANSI Class 3 high visibility safety garments should be worn. Class 2 apparel may be worn in some situations. Other personal protective equipment (PPE) that should be worn includes, but is not limited to, hearing protection, hard hat, safety goggles, hard-soled boots, and gloves.
- **Work zone laws and regulation enforcement:** Teach and remind construction workers and drivers about the work zone laws and regulations. Inform them of the basic points of view regarding the importance of worker safety in a work zone.
- **Work zone infographic study.** Learn to recognize the warning signs in the work zones, and know what should be done when you see different warning signs and under different circumstances.
- **Sign and device spacing and placement:** When planning to work in a construction work zone, learn the guidelines related to signs and other traffic control measures in order to keep yourself safe. Learn how and where to place the signs and devices, and know how to operate them.
- **Traffic control plans and worker safety planning:** Make a traffic control plan and safety plan in advance when you need to work or collect data in a construction work zone. Do some Internet map searches to check nearby environments. Make a plan associated with your arrival time to the site to reduce the influence to native traffic and keep yourself safe.
- **Flagging and other traffic control measures (TCMs):** Learn about flagger operations and other traffic control measures, focusing on how to guide the traffic correctly so that it can pass through the work area safely and keep the drivers and workers safe.
- **Previous case studies:** Do some research and investigation into accident case studies that have been written. Understand the importance of construction work zone safety,

and try to avoid the circumstances that led to the accidents described in the case studies.

- **Expect the unexpected:** Do not trust the coming traffic passing through the work zone. Assume the drivers do not see you; assume that the drivers are distracted by something else. Be prepared for all of the possible hazardous conditions that might exist in a highway/roadside construction work zone.

Some other safety topics, though not commonly addressed as safety concerns for construction workers, are very important for student workers, interns, and new employees. Two safety topics that were identified which are particularly applicable to student researchers are:

- **Personal electronic uses:** Cell phones are now a useful tool that people use frequently, especially students. However, improper use of personal electronic devices in a work zone can be dangerous. Students should know proper safe use of personal electrical devices in work zones. When to use and not to use a cell phone while in a work zone is a question that every student worker should be able to answer.
- **Get enough rest:** Get enough rest before the day you work on-site. Be sure to get two full nights of sleep (at least 7 hours each night) before working the night shift. Long naps (2 hours) in the mid-afternoon prior to the night shift help reduce sleep debts. During the work period, the best naps are 10-12 minutes long and perfect during lunch breaks. If intermittent day and night work shifts are required, establish a 4-hour anchor sleep time each 24 hour period and supplement this sleep time with naps (OregonDOT 2016).

2.3 WORK ZONE SAFETY HAZARDS AND RISK ANALYSIS

Like the safety topics in construction work zones described above, the safety hazards and related safety risks can also be divided into two categories: vehicle hazards and on-site hazards. Based on the references reviewed, those hazards and risks are as shown below for each category:

Hazards Identification:

- Vehicle Hazards
 - Drivers distracted
 - Vehicles travelling at high speed and cannot stop within available stopping distance
 - Drivers visibility of workers impaired
- On-site Hazards
 - Workers not wearing safety equipment
 - Blind spots for mobile equipment
 - Holes in protected work area and stripping
 - Warning signs on-site not clear
 - Workers do not know safety regulations and practices
 - Workers conducting work processes and procedures incorrectly
 - Workers distracted
 - Workers fatigued

- Lack of hazard reporting system

Related Safety Risks:

- Vehicle Risks
 - Vehicles crashes in the work zone and causing injuries and fatalities
 - Drivers not seeing the workers, and hitting the workers
- On-site Risks
 - Falls
 - Slipping, tripping
 - Hit by mobile equipment
 - Workers placing other priorities first (i.e., decreasing the importance of safety relative to other priorities such as productivity and quality of the work)
 - Incorrect work procedures and operation of equipment

2.4 WAYS TO ELIMINATE HAZARDS, REDUCE RISK, AND PREVENT INJURIES AND FATALITIES

To prevent injuries, the most effective way is to eliminate or reduce the potential hazards that appear on or around the site. For roadside work areas and construction work zones, hazard elimination should include both on-site hazards and vehicle hazards. Vehicle hazards are the most common reasons for many work zone accidents. The following are some ways to eliminate and reduce the safety risk in work zones.

- **Training:** All workers and student workers should be trained on how to work next to motor vehicle traffic and mobile equipment in a way that minimizes their vulnerability (Construction Safety Council 2008a).
- **Worker Safety Apparel:** All workers exposed to the risks of moving roadway traffic and construction equipment should wear high-visibility safety apparel meeting the requirements of ISEA “American National Standard for High-Visibility Safety Apparel” and labeled as ANSI 107 standard performance for Class 1, 2, or 3 risk exposure as appropriate for the working conditions (Construction Safety Council 2008b).
- **Mobile barrier:** Use of a mobile barrier (e.g., a semi-truck cab equipped with a trailer provides a barrier to the passing traffic) eliminates safety hazards and reduces safety concerns such as errant vehicles. Such a barrier creates a “wall of steel” around the work zone that allows workers to concentrate on the work (Tymvios and Gambatese 2014).
- **Presence of equipment and strategically-planned operations:** Contractors may utilize the presence of equipment and strategically-planned operations to benefit safety. Keeping a large, illuminated piece of equipment close to workers may help to get the motorist’s attention and make them reduce their speed (Zhang and Gambatese 2016).

- **Prevention through design (PtD):** A well-organized plan before implementing the work process is very effective. The elimination or significant reduction of risks at the design stage with respect to tools, materials, processes, and procedures, holds great promise for the reduction of occupational safety and health risks in construction operations (Young-Corbett 2014). PtD can be an effective safety intervention for work on roadways.

2.5 FORMAT FOR SAFETY TRAINING

Different formats for safety training are commonly used, including written manuals, videos, on-line interactive training modules, short guidelines, tip sheets, and in-person training. The advantages and disadvantages of each safety training method that were identified in the literature review are discussed in this section.

- **Written manual:**
 - *Advantages:*
 1. Serves as an orientation tool. Without a manual, they will have to rely more heavily on staff who may be busy doing other things (Duncan Kent & Associates, Ltd., no date).
 2. Meet legal or regulatory requirements. In most instances, a safety manual is required by legislation. A well-documented manual and carefully reviewed procedures can reduce a company's liability for safety incidents (Duncan Kent & Associates, Ltd., no date)
 3. Suitable for long messages about safety (Patil 2013).
 - *Disadvantages:*
 1. May be a slow and time consuming process. New workers may not have the patience to read through the manual (Patil 2013).
 2. May be lengthy and expensive. A written manual usually includes a lot of content in order to cover every aspect; the cost of printing and editing may be high (Patil 2013).
 3. Potential lack of personal touch. Sometimes it is difficult to persuade or motivate new workers through a written document (Patil 2013).
- **Videos:**
 - *Advantages:*
 1. Reduced cost. Videos can reduce planning and organization of in-person training and eliminate the physical cost of training (mediaplatform 2015).
 2. Potentially more effective and less time consuming. Compared to written manuals, video training provides visual and sound contact with the trainees, and express messages more directly.
 - *Disadvantages:*
 1. Short videos cannot cover everything, and long videos may make the trainees bored and distracted.
 2. Limited opportunity for feedback after trainees are finished watching the videos. It is hard to know if the trainees absorb the knowledge and key points.

- **On-line Interactive Training Module:**
 - *Advantages:*
 1. Easy to get feedback by giving a small quiz after each on-line training section.
 2. New workers can receive enough knowledge by finishing all required and elective sections.
 3. Easy to track the progress of the trainees' learning.
 - *Disadvantages:*
 1. Lack of in-person contact. All the trainees get only written content, without any experience shared and on-site observations.

- **Short Guideline and Tip Sheet:**
 - *Advantages:*
 1. Easy to carry. Workers can take it with them and check for some tips while working in the field.
 2. Reduced printing costs compared to written manual.
 3. Short guideline/tip sheet focuses more on on-site operation rather than the theoretical regulations.
 - *Disadvantages:*
 1. Short tips could not cover solutions for every aspect of safety issues.

- **In-person Training:**
 - *Advantages:*
 1. Plenty of experience sharing from professionals will provide the new workers a direct idea of the on-site hazard identification and risk prevention.
 2. With the interaction between the trainees and the trainer, the in-person training can solve many of the confusions that new workers have.
 - *Disadvantages:*
 1. Potential increased cost. An in-person session may require more time for training personnel, and therefore higher personnel costs.
 2. The trainers may not cover every aspect that the new workers should be aware of.

3.0 SURVEY DEVELOPMENT AND DISTRIBUTION

The on-line surveys regarding student researcher safety in roadside applications and work zones aim to gather information from both contractors and DOTs on the suggestions and perspectives of student researcher safety issues and training needed before entering roadway work areas. The overall goal was to gather information that will help to develop the training materials to ensure student researcher safety while working or collecting data in or near roadside work zones. Provided below is a description of the survey structure and process.

3.1 SURVEY STRUCTURE

The survey process began with the development and distribution of a survey questionnaire. The researchers created a questionnaire for use in the survey that contained six sections and consisted of a total of 20 questions. The six sections were as follows:

- **Part 1 – Demographic information.** Gathered basic demographic information about the participant’s employment and experience, such as job title, type of employer, and type and duration of work experience.
- **Part 2 – Key terms definitions.** Provided definitions of two key phrases that appeared in most of the survey questions: “student workers” and “roadway work site”.
- **Part 3 – Student worker information.** Asked the participants if they had student researchers on their previous projects and how they thought the student researchers performed with respect to safety.
- **Part 4 – Student worker safety concerns.** Focused on those participants who had student researchers on their previous projects, and asked the participants to share their concerns about student researcher safety.
- **Part 5 – Safety training information.** Asked about safety training methods that would be most suitable for the student researchers while the students are working in or near roadside work zones.
- **Part 6 – Specific safety requirements for student workers.** Asked the participants to share their opinions on student worker safety training, and whether they have a near miss reporting system in their organizations.

The survey ended with a question to the participants to share their suggestions regarding the safety training of student workers in work zones. A copy of the survey questionnaire is provided in the Appendix.

To support the development of the questionnaire, direct emails were sent to the faculty in the School of Civil and Construction Engineering at OSU and the Department of Civil and Environmental Engineering at Portland State University (PSU) to obtain their input on student worker safety. Each of the faculty was asked if they have students who go out to roadway sites to perform research activities. If so, the faculty member was asked to respond to two questions:

- What typical research activities do students perform on roadway sites for your research studies?
- What types of safety training would you recommend for students who perform research activities on roadway sites?

Three responses were received from OSU faculty, and two responses from PSU faculty. The responses from the faculty were used to inform the survey questions, specifically to provide examples of activities and safety training that should be incorporated in the survey questionnaire.

3.2 SURVEY ADMINISTRATION

A draft questionnaire was initially developed for the TAC's review, and then revised to incorporate the TAC's input. The draft survey was reviewed and subsequently approved by the Institutional Review Board (IRB) at Oregon State University (OSU). The IRB approval letter is provided in the Appendix. The online survey was hosted and administrated through the Qualtrics survey system supported by OSU (<http://main.oregonstate.edu/qualtrics>). Anonymity of the respondents was required by the IRB so that survey responses could not be associated with specific respondents.

3.3 SURVEY DISTRIBUTION

Industry practitioners who are employed in positions associated with roadway operations and construction were targeted for survey distribution. The contacts used for the survey distribution were obtained from the following sources:

- Highway Council membership within the Associated General Contractors (AGC) Oregon Columbia Chapter
- Members of the AGC of Washington that are listed as heavy civil, roadside work, and asphalt contractors
- Department of Transportation (DOT) personnel in all 50 states
- Educational institutions (OSU and PSU)

The contact list of the Highway Council of AGC-Oregon is posted on the AGC-Oregon website, and contains a total of 39 members. Similarly, the AGC of Washington member list is posted on the AGC of Washington website. The researchers reviewed the full AGC of Washington member list, and the contact information for those members that were listed as working in heavy civil,

roadside construction, and highway-related companies was downloaded for distribution of the survey. A total of 97 contacts were recorded from the AGC of Washington member list.

The survey questionnaires were separately distributed to the contractors and to the DOTs. For the contractors, the Qualtrics system was used to distribute the survey by email. The DOT survey was distributed by the ODOT Research Office via email. Both surveys questionnaires were available on-line between March 7 and May 15, 2017.

4.0 SURVEY RESULTS AND ANALYSIS

4.1 SURVEY RESPONSES

A total of 18 highway construction professionals and 34 professionals from DOTs completed the survey questionnaire (total of 52 responses). Fully completed questionnaires were received from 28 of the 52 respondents. Nevertheless, 32 respondents provided responses to the first several demographic questions.

Figure 4.1 shows the distribution of respondents according to their work organization. Of the 32 respondents who provided demographic information, 11 (34%) of the respondents work in a DOT, and 15 (47%) of the respondents work for a roadway construction contractor or subcontractor. This distribution percentage is representative of the population that was sampled by the researchers. The target sample was intentionally chosen to represent the population that would likely have some knowledge and concerns of student researcher safety.

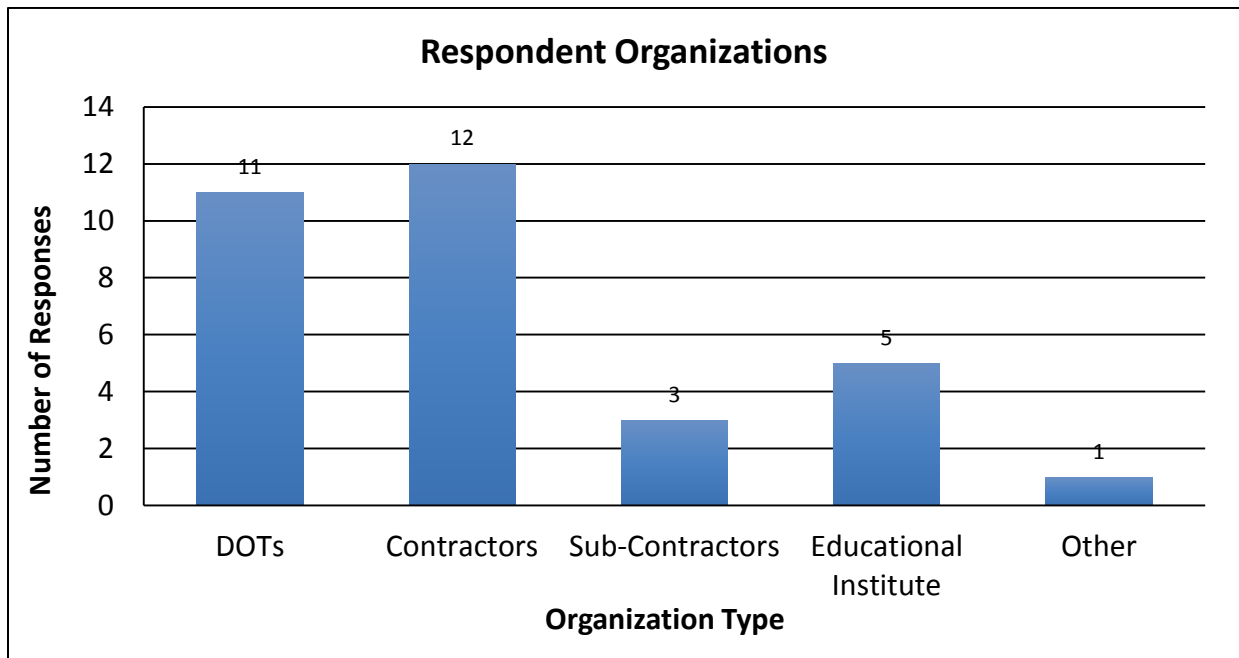


Figure 4.1: Distribution of Respondents' Organizations (n = 32)

Responses were received from different professionals in various work positions who are involved in the highway construction industry. As shown in Figure 4.2, 25% of the responses came from project managers, while educational and research institute personnel (research manager, professor, and some respondents from "other") provided more than 25% of the responses.

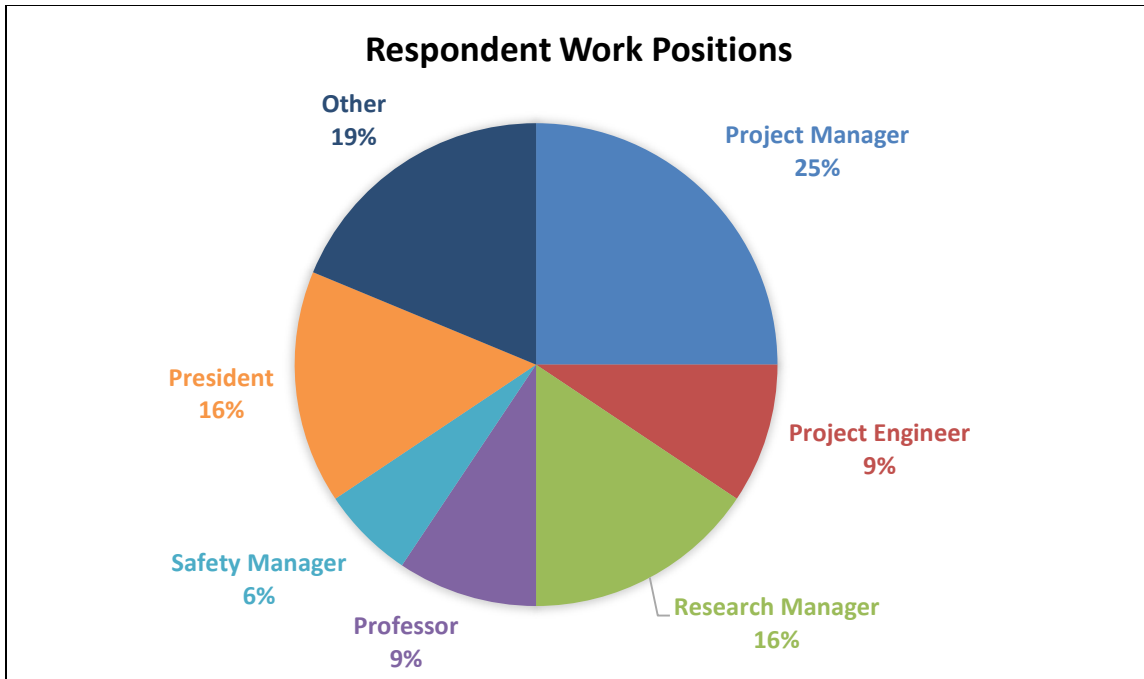


Figure 4.2: Respondents Distributed according to Work Position (n = 32)

Figure 4.3 shows the distribution of the respondents based on the number of years of experience in the roadway design/construction industry. The figure shows that more than 80% of the respondents have more than five years of industry experience or research experience. Since upper management employees represent a considerable number of the respondents, it is comprehensible that 68% of the respondents have over 20 years of construction experience.

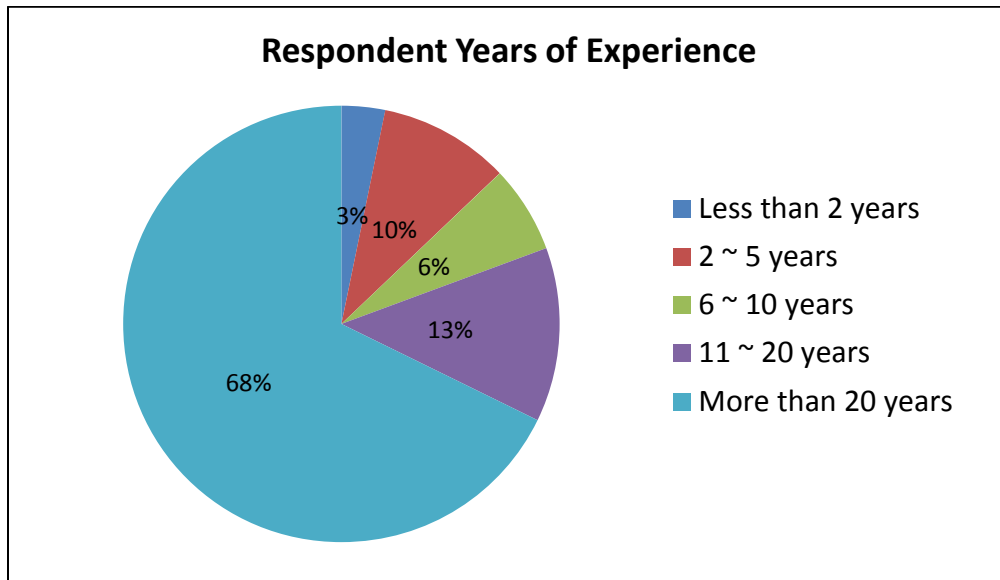


Figure 4.3: Respondents' Years of Experience (n = 31)

Among those individual or company respondents who have had student researchers working on the roadway during their projects, the respondents mentioned the locations that student researchers typically work. The locations are mainly distributed amongst roadway work zone activities, roadside data collection, roadside sample collection, and other (see Figure 4.4). Based on the 11 responses to this question, most of the student researchers (64%) work on activities that involve roadside data collection, and roadside sample collection (55%). Other activities represent water sampling from bridges, field observation of traffic movements in bridge research projects and work zone safety research projects, and analyzing traffic data typically provided by the DOT.

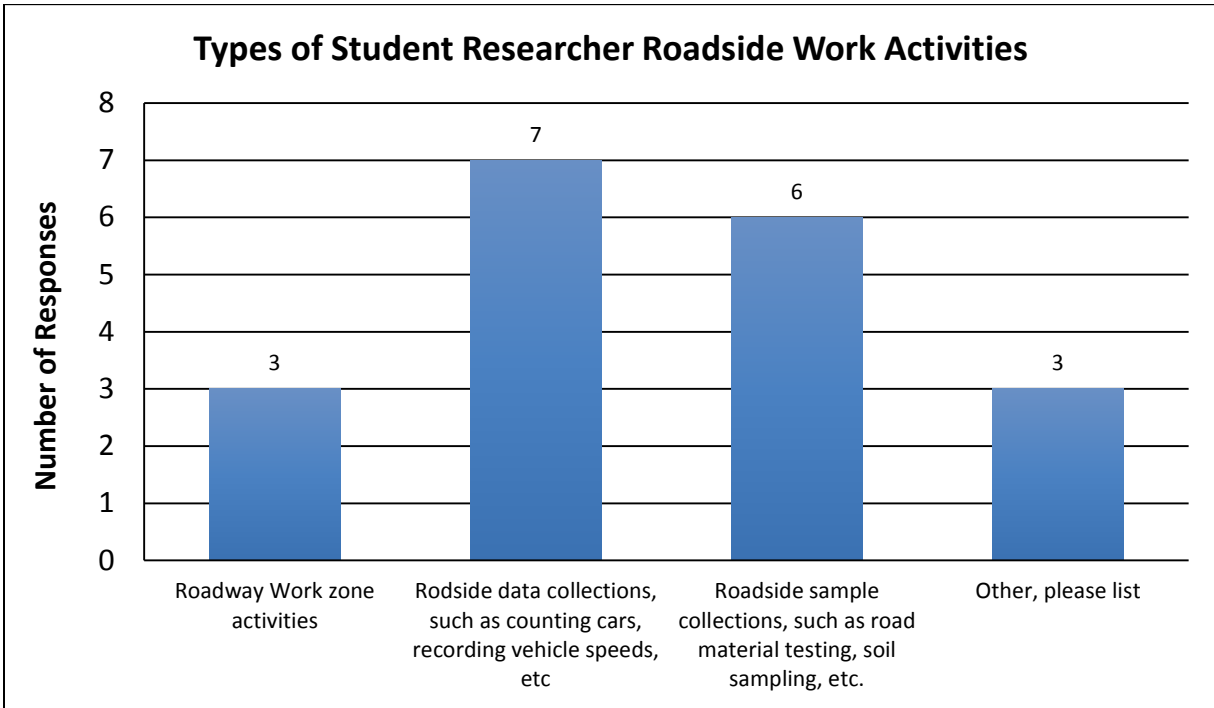


Figure 4.4: Student Researcher Roadside Work Activity Distribution (n = 11)

Accordingly, the respondents perceived that student researchers perform, on average in terms of safety, at a low level compared with full-time on-site workers. The respondents indicated that student researchers perform well in some situations and do not perform well in others. Among all different situations, Table 4.1 shows the situations that respondents think student researchers perform well in with respect to safety. The responses suggest that student researchers tend to perform better with supervision from an experienced person or faculty member. On the other hand, Table 4.1 also shows the situations in which student workers are perceived to not perform well with regards to safety. Supervision is one of the significant issues. Lack of safety training and instruction, and improper preparation, may also result in poor safety performance.

Table 4.1: Situations in which Student Researchers Perform Well and Do Not Perform Well with regards to Safety (n = 11)

Type of Work Zone Situation	
Perform Well	Do Not Perform Well
When an experienced worker is with them and supervised by the experienced worker	When they are not supervised by someone experienced
When there is the opportunity to express to them the importance of paying attention to safety and the dangers that exist	When in a hurry and no supervision
With supervision from faculty and professionals to remind them of safety procedures	When there is a cultural challenge where the student researcher is just not experienced in the dangers present in a work environment
Under supervision with proper safety equipment	Absent training and instruction; also may take more risks
During collection of data	Active construction projects (usually a communication issue)
When they have good preparation and safety training from their professor and the state DOT	When they visit research sites without proper preparation, communication with the state DOT, or safety training
When they are typically in safe areas at any work site	Traveling to and from work sites. Driving an automobile to the observation site is a risky task
When the students receive a safety briefing by the staff or Maintenance and Operations (M&O) staff	

While observing student researchers conducting research activities on a typical roadway, both the contractors and DOTs share similar concerns with regards to safety. Based on the survey responses received, a total of 11 respondents answered the question, “With regards to safety, what concerns you most when you see student workers working in construction work zones? Please select all that apply.” The responses, “Not paying attention” and “Do not know the safety hazards present,” were most often chosen by the respondents (8 and 9 times, respectively). Among all of the concerns listed, the respondents indicated that hazard observation and analysis, paying attention to the work, and proper safety training could eliminate the main safety concerns. Figure 4.5 shows all of the concerns mentioned by the respondents when they see student researchers conducting research activities on a typical roadway.

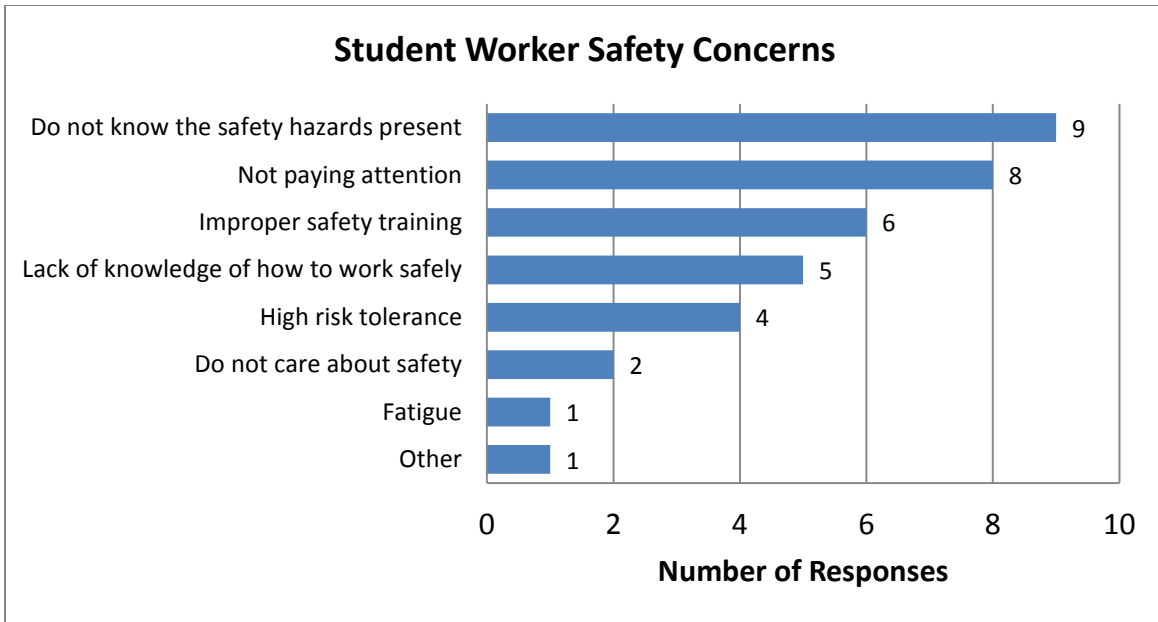


Figure 4.5: Safety Concerns of Student Researchers Working in Work Zones (n = 11)

The survey results show that 100% of the respondents think safety training for student researchers is necessary. Additionally, in terms of the format for the safety training, a total of 25 responses were received for this question (see Figure 4.6). Most of the respondents regard in-person training as the most effective safety training method. Using a combination of training techniques was identified as the second-most effective training method, which includes in-person and online training, in-person and video training, in-person training and short guideline/tip sheet, and in-person training and written manual. In-person training is included in all combinations of training methods. Among all 25 responses, a total of 20 respondents think in-person safety training is the most effective method (11 in-person + 8 combination + 1 other), which represents 80% of all respondents.

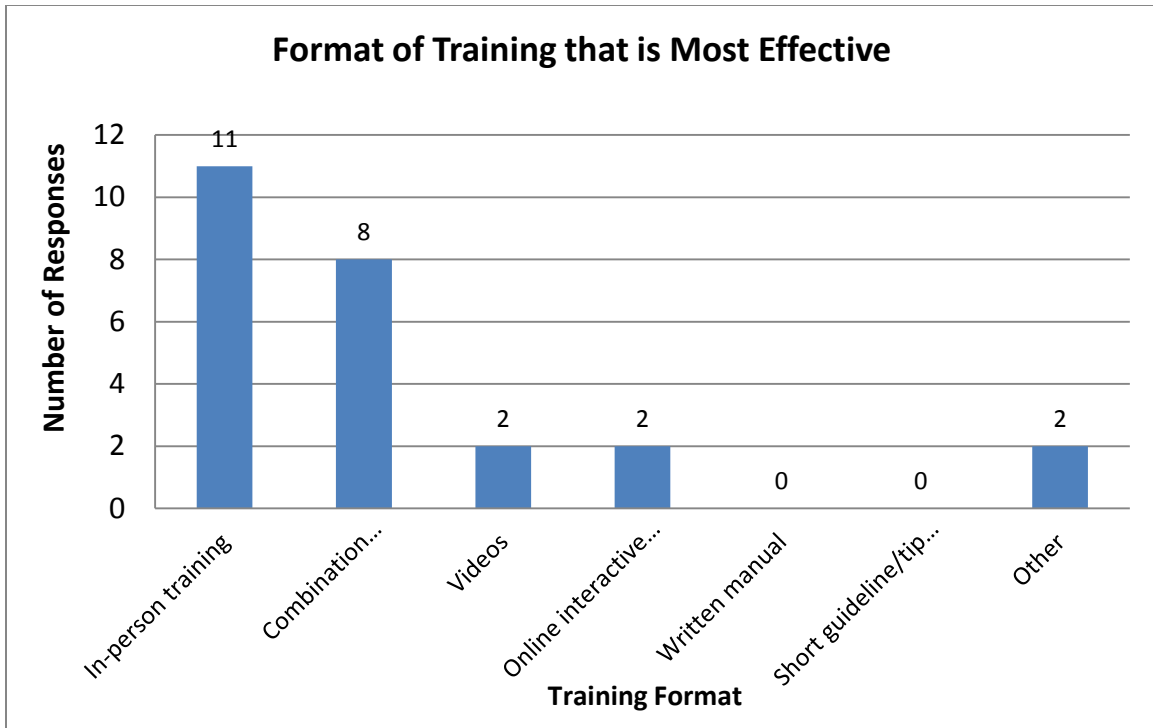


Figure 4.6: Format of Safety Training that is Most Effective (n = 25)

Most of the survey respondents agreed that students should receive at least one hour of safety training every week (65% of all responses) or before entering a work zone (43.5% of all responses). Depending on the frequency and severity of the project, safety training should be reasonably scheduled. Training time around one to two hours would be the best; one hour video plus one-hour in-person training is a method that most of the respondents agreed with as being preferable.

Figure 4.7 summarizes the recommended training content. Among all of the responses related to safety training content, 23 out of 25 respondents (92%) agreed that how to use personal protective equipment (PPE) and how to work around equipment are important training topics. According to the respondents, other topics that should be covered in safety training include: warning signs and signals, environmental hazards training, planning safe escape routes, and staying behind guardrails or at a fair distance outside of clear zones and not on sidewalks inside clear zones.

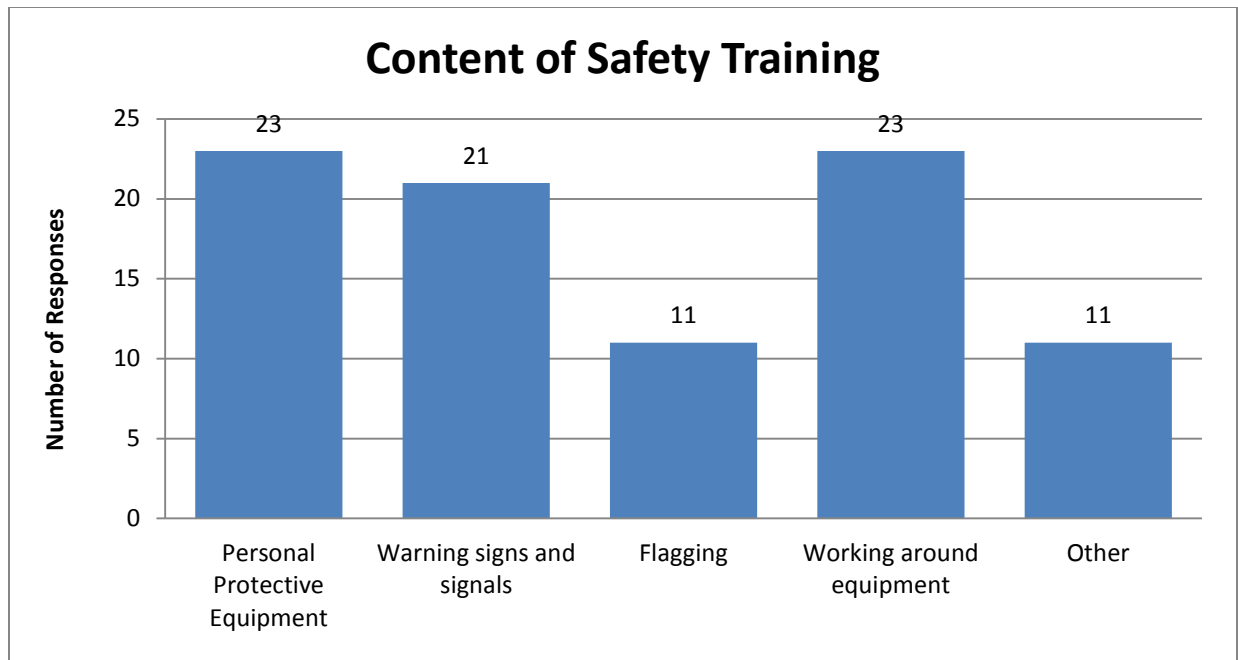


Figure 4.7: Content that should be Included in the Safety Training (n = 25)

Roadway construction and maintenance workers are experienced working on construction and maintenance sites, and have their own rules and regulations to follow with regards to safety. For student researchers, most of whom do not have experience working on roadways, a research question that arises is whether they need extra safety training other than the normal/typical training provided to roadway construction and maintenance workers. According to the survey results, 14 of 25 respondents (56%) said that there is no need for the student researchers to receive different or additional safety training compared to that given to regular, full-time workers. The other respondents (44%) hold the opposite opinion (i.e., student researchers should be given specialized training that is different than that given to typical employees).

For those respondents who agreed that student researchers need different or additional safety training, the respondents believe that if student researchers only work at a specific time or in specific locations, they would not need to receive all of the safety training that normal, full-time employees need. For student workers, their safety training should include the specific tasks that they will be performing in addition to general safety training. The additional training also should be more directed at where the student researchers will be working and what will be taking place at that location.

For some specific topics, such as personal cell phone use in the work zone, taking enough rest for the work day, and having experienced workers share their safety knowledge with new student researchers, there are no formal regulations present that cover these issues. However, these topics are considered by most of the respondents to be especially important for student workers.

When asked how they would suggest that safety risks for student researchers should be prevented and eliminated on-site, the respondents provided different opinions. The lists below show the common responses from both the DOT and contractor personnel:

- From the DOT's perspective:
 - *Prior training AND direct supervision on-site by experienced personnel cannot eliminate all risks. Training and awareness can minimize risks.*
 - *The roles and responsibilities of each student researcher along with general safety requirements should be defined before arriving at the site. Too often the professor has not expressed this to the student researchers prior to arriving on the site.*
 - *A safety plan is developed for each project.*
 - *Job safety analysis (JSA) discussion prior to boots on the ground for each shift/day.*
 - *DOT's should minimize risk and not allow students to go to unsafe situations.*
 - *Minimize the amount of work that needs to be performed on the jobsite. Utilize other tools that keep student researchers off the roadway on projects.*
 - *Proper preparation and safety training, and oversight by the professor and state DOT personnel.*
 - *Proper training.*
 - *By assuming drivers of cars may have accidents and lose control of their vehicles.*
 - *Education, limit exposure, and, if exposed to safety hazards, need proper safety equipment in training.*
 - *Limit their exposure to active traffic; do not use in urban areas with heavy traffic; and have experienced adult supervision on site.*

- From the contractor's perspective:
 - *Simply respect that contractors have a project to build; make sure not to interfere with production and take time to understand your surroundings.*
 - *No cell phones/electronic devices on-site.*
 - *It only takes a second to be in the wrong spot at the wrong time.*
 - *We appreciate the work and research that student workers are performing, but from what I've heard, they don't realize the significance of the potential hazards.*
 - *Student workers are the same as any other person in the work zone and should be treated the same.*
 - *The students need to work under the direction of the project superintendent or his/her designee.*

4.2 SUMMARY OF CURRENT PRACTICES

The survey collected useful information about student worker safety from DOTs, the construction industry, and educational institutes. The survey also targeted determining the level of awareness of student researchers' safety amongst owners (DOTs), contractors, and research education institutes. The results of the survey suggest the frequency, duration, and content of the student researcher safety training. Based on their past experiences and personal perspective, the survey participants illustrated reasonable concerns and possible safety training content that should be taken by the student researchers.

Besides the survey questions and results received from the survey questions, there is some additional information of interest that can be found in the survey responses. After distributing the request to participate in the survey to the email list of more than 400 people, only 52 people responded. Within the 52 respondents, 41% are either project managers or presidents of the companies. The large percentage of responses from positions higher up in organizational management may indicate that student researcher safety issues are receiving more attention by the management groups within the industry. Worker safety or temporary student worker safety issues have been primarily contractor or sub-contractor concerns. In recent years, management personnel are becoming more aware of and concerned about safe operations in work areas for all people on the work site.

Overall for the entire study, the findings and comments from the survey were incorporated into the subsequent tasks within the research study work plan. A focus group of TAC members was formed to evaluate the survey results and recommend content to be included in the student researcher safety training manual and video. The safety manual and video are described in the following section of the report.

5.0 SAFETY MANUAL AND VIDEO

Utilizing the information gathered from the literature review and survey, the research team developed a video and manual specifically for student researcher safety training. The manual and video are described in detail below.

5.1 SAFETY MANUAL

The safety manual contains seven sections: introduction and background, injury and fatality data, hazard analysis, hazard control methods, emergency response, references, and additional resources. The injury and fatality data section quantitatively illustrates the safety performance of the transportation industry near or in roadway construction work zones in recent years. This section also points out the importance for the workers to receive safety training, and to treat field work safety seriously. The safety hazards analysis section lists the majority of the potential hazards that student workers and researchers could experience while working in roadway field sites. The manual then discusses worker safety risks, and indicates that the risks are usually caused by passing vehicles, site hazards, and worker behaviors. A list of 16 most frequently occurring hazards together with their brief descriptions are listed. This list indicates why it is not safe under such situations, and what student workers and researchers need to do to reduce or eliminate the potential incidents from occurring. In reaction to those hazards, the controlling hazards section of the manual indicates the necessity of safety training, and of preparing a safety plan prior to going out to the site. This section describes what students should know before entering the field sites, and what they need to do if incidents injury incidents occur while they are in the field. A copy of the safety manual is available under the ODOT Research Publications web page, located at the following link:<http://www.oregon.gov/ODOT/Programs/Pages/Research-Publications.aspx>.

5.2 SAFETY VIDEO

In addition to the safety training manual, a safety training video was developed, produced, and recorded by ODOT Photo and Video Services, with the assistant from the OSU research team and ODOT employees. To make the video more applicable to different types of work sites, and make it easier to understand the safety needs in the different types of work sites, the research group went to several different work sites to record the video. The first site was at the Corvallis Airport where there was a quiet area with few vehicles and straight sections of roadway. The research group repeated several of the activities that student researchers may need to participate in, including sensor placement, traffic speed monitoring, entering/exiting a work zone, and total station operation. All repeated activities demonstrated a safe way of performing the activity and showed student researchers working in pairs. Another site that the research group recorded video at was at a parking lot re-paving in Corvallis, OR. This was an actual, on-going project with roadway paving and maintenance equipment present. The research group illustrated how to behave in or near a construction work zone, and demonstrated where to stand to keep themselves safe beside large equipment. Additionally, another large project visited for the videotaping was on Oregon Highway 20, a two way, two lane highway in rural Oregon. The video includes scenes taken from the site to illustrate the high levels of noise from large equipment, fast speed of the passing traffic, and lack of visibility of the workers. On that site, the research group

demonstrated where and how to park their vehicle safely in a designated highway work zone area; cell phone use policy; and personal protective equipment required (including sufficient hydration and sunscreen). The video is approximately 12 minutes and 45 seconds long. The video is available at the Oregon DOT YouTube Channel, located at: https://youtu.be/iz_fde-xtxc.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The overall objective of this study is to create safety training resources for student researchers working in roadside areas and work zones. The resources are aimed at a national-level audience. To achieve such a goal, the researchers collected data separately from literature review and an on-line survey, and put emphasis on defining the types of safety hazards that a student researcher is exposed to, and what should the safety manual and video include and how should it be organized. In order to meet the requirements of the work plan, the researchers began by conducting a literature review to collect basic ideas from existing safety manuals, videos, and brochures. Next, surveys were distributed to roadside contractors, educational institutes, and DOTs in all 50 states. This section of the report presents conclusions that can be derived from each research task performed as part of the study and provides recommendations for future research studies and safety training development activities.

6.1 DOCUMENTATION OF EXISTING ROADSIDE WORKER SAFETY CONCERNS AND RESEOURCES

A detailed list of all reviewed literature (papers, videos, brochures, and websites describing current practices) was developed and is presented in the report. The detail and contents of each literature review was recorded in the appendix. A total of 39 current resources were reviewed and recorded, including those publications from different state DOTs, and safety videos published by educational institutes and other organizations. Based on the literature reviewed, the safety issues commonly considered to be of concern for those workers in roadway work zones include: the presence of high speed vehicles passing through the work zone, a lack of visibility of the workers by motorists, worker recognition and adherence to safety regulations while in work zones, misplacement of temporary signage and other traffic control devices, a lack of safety planning prior to entering the work area, inexperience in working in roadway work zones, inappropriate use of cell phones and other mobile technologies while in roadway work zones, and fatigue due to lack of rest and over exertion. Safety training resources should contain content that instructs student researchers how to mitigate all of these safety concerns.

6.2 SURVEY OF CURRENT SAFETY TRAINING PRACTICES

The survey collected useful information about current practices from the construction industry, educational institutes, and DOTs. The survey also targeted determining the level of awareness with regards of student researcher safety amongst DOTs, contractors, and educational institutes. This survey results suggest the frequency, duration, and content that should be included in student researcher safety training. Based on the survey participants' experiences, they illustrated reasonable concerns and possible safety training that should be given to student researchers. Overall, the safety training should address the identified risks and common behaviors of student researchers. Training should address the use of PPE, especially reflective apparel, how to act in the presence of large, mobile equipment, how to protect oneself when adjacent passing vehicular traffic, proper procedures for entering and exiting a work site, the need for planning for safety prior to going on the work site, and protecting oneself through the appropriate use of cell phones and not being fatigued. Besides the survey results, there is some additionally important

information that can be concluded from the survey. After sending the survey to the email list of more than 400 people, only 52 people responded. And within those 52 people, there was a significant number (41%) of project managers and presidents of companies who responded, which indicates that student researcher safety is receiving attention by company management personnel within the industry. Worker safety, or temporary student worker safety, issues have been contractors' concerns. In recent years, management personnel are becoming more aware of and interested in ensuring safe sites and safe operations for their workers and others on their field sites, including those student researchers who work for academic institutions.

6.3 SAFETY TRAINING RESOURCES

The safety manual and video created from this study create resources for a unique group of workers on field sites: student researchers. Student researchers are often sporadically on field sites and are typically not part of the planned work zone operations. In addition, student researchers typically receive little or no training, in the classroom or elsewhere, regarding how to ensure their safety while in work zones. The training resources created fill the need for resources to help train student researchers. Designed for a student researcher audience, the video shows and describes needed safety precautions. The safety training manual describes in detail how to plan for and be safe in work zones. Special attention should be given to creating and presenting resources that will capture the attention of student researchers, and to making the resources available to all who are in need of the training. The safety manual and video are expected to help student researchers be aware of the safety needs while conducting their work, and ultimately help to prevent additional work zone injuries and fatalities. Universities, DOTs, contractors, and other organizations that send students and/or new workers into work zones to conduct research-related activities are encouraged to utilize the video and manual to train their personnel. Distribution of the resources to these entities across the US is recommended.

Further development of the video and manual may be warranted following continued use and evaluation of the resources. Feedback regarding the content and format of the video and manual should be solicited from the users in order to benefit from the experiential knowledge gained from their implementation and identify how to improve the resources. In addition, insights into the benefits received from implementation of the resources should be collected and reported to demonstrate their effectiveness and value. Additional formats for the training resources, e.g., on-line training module, should also be explored as means for improving learning associated with the training.

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APPENDIX A

A.0 REFERENCES AND SUMMARY OF LITERATURE REVIEW

Ref.	Title	Link	Format	Expect the unexpected. Assume drivers don't see you	Beware of complacency - in yourself and coworkers	Avoid having your back to traffic or use a Spotter to watch your back for you	Waring ANSI Class 3 high visibility safety garments, at least Class 2 (High-visibility safety apparel)
1	ODOT-2016 WorkZoneFactSheet	http://www.oregon.gov/ODOT/TS/docs/Workzone/2016_WorkZoneFactSheet%2020160503.pdf	Handbook	X	X	X	X
2	2011 Oregon Temporary Traffic Control Handbook (For operations of three days or less)	http://www.oregon.gov/ODOT/HWY/TRAFFIC-ROADWAY/docs/pdf/2011_OTTCH.pdf	Handbook				X
3	Intersection Safety - A manual for local rural road owners	http://safety.fhwa.dot.gov/local_rural/training/fhwasa1108/fhwasa1108.pdf	Handbook				
4	Roadway Departure Safety - A manual for local rural road owners	http://safety.fhwa.dot.gov/local_rural/training/fhwasa1109/fhwasa1109.pdf	Handbook				
5	Road safety information analysis - A manual for local rural road owners	http://safety.fhwa.dot.gov/local_rural/training/fwasaxx1210/lrro_data.pdf	Handbook				
6	OSHA - Highway work zones and signs, signals, and barricades	https://www.osha.gov/doc/highway_workzones/	Online Source				X

7	Building safer highway work zones. Measures to prevent worker injuries from vehicles and equipment	http://www.cdc.gov/niosh/docs/2001-128/pdfs/2001-128.pdf	Publication				X
8	OSHA instruction - Inspection and citation guidance for roadway and highway construction work zones	https://www.osha.gov/OshDoc/Directive_pdf/CPL_02-01-054.pdf	Handbook				X

Ref.	Title	Do Not use personal electronics while operating equipment	When you need electronics for your job, remember to look up often and in alternating directions	Do Not use electronics while flagging	Practice working with any electronic devices you need to use before getting on the jobsite	Have devices properly mounted instead of trying to hold them	Only use personal electronics in approved safe zones or during breaks
1	ODOT-2016 WorkZoneFactSheet	X	X	X	X	X	X
2	2011_ Oregon Temporary Traffic Control Handbook (For operations of three days or less)						
3	Intersection Safety - A manual for local rural road owners						
4	Roadway Departure Safety - A manual for local rural road owners						
5	Road safety information analysis - A manual for local rural road owners						
6	OSHA - Highway work zones and signs, signals, and barricades						
7	Building safer highway work zones. Measures to prevent worker injuries from vehicles and equipment						
8	OSHA instruction - Inspection and citation guidance for roadway and highway construction work zones						

Ref.	Title	Take personal cellphone in case of emergency	Be aware of the surroundings when using handheld devices	If you need longer focus, have a spotter next to you to watch for risks	Be sure to get two full nights of sleep (7 hours each) before working the night shift	Long naps (2hours) in the mid-afternoon prior to the night shift help reduce sleep debts	Best naps are 10-12 minutes long. Perfect for during lunch breaks
1	ODOT-2016 WorkZoneFactSheet	X	X	X	X	X	X
2	2011_Oregon Temporary Traffic Control Handbook (For operations of three days or less)						
3	Intersection Safety - A manual for local rural road owners						
4	Roadway Departure Safety - A manual for local rural road owners						
5	Road safety information analysis - A manual for local rural road owners						
6	OSHA - Highway work zones and signs, signals, and barricades						
7	Building safer highway work zones. Measures to prevent worker injuries from vehicles and equipment						
8	OSHA instruction - Inspection and citation guidance for roadway and highway construction work zones		X				

Ref.	Title	If intermittent day and night work shifts are required, establish a 4-hour anchor sleep time each 24 hour period and supplement with naps	Make exercise/stretching part of the daily routine	Stay hydrated with water	Watch for signs of fatigue in others	Report near misses and unsafe behavior of co-worker to a supervisor	Work zone Infographic study
1	ODOT-2016 WorkZoneFactSheet	X	X	X	X	X	X
2	2011_Oregon Temporary Traffic Control Handbook (For operations of three days or less)						X
3	Intersection Safety - A manual for local rural road owners						X
4	Roadway Departure Safety - A manual for local rural road owners						X
5	Road safety information analysis - A manual for local rural road owners						
6	OSHA - Highway work zones and signs, signals, and barricades		X				X
7	Building safer highway work zones. Measures to prevent worker injuries from vehicles and equipment		X				
8	OSHA instruction - Inspection and citation guidance for roadway and highway construction work zones		X				X

Ref.	Title	Do not control traffic with a spotter. A spotter is not a flagger.	Work Zone Components	Sight and Device Spacing and placement	Flagging and other Traffic Control Measures (TCM)	Case studies and experienced story telling	Safety information/statistics/ data collection and analysis	Work zone law and regulation enforcement
1	ODOT-2016 WorkZoneFactSheet							
2	2011_Oregon Temporary Traffic Control Handbook (For operations of three days or less)	X	X	X	X			
3	Intersection Safety - A manual for local rural road owners			X				
4	Roadway Departure Safety - A manual for local rural road owners					X		
5	Road safety information analysis - A manual for local rural road owners					X	X	X
6	OSHA - Highway work zones and signs, signals, and barricades			X				X
7	Building safer highway work zones. Measures to prevent worker injuries from vehicles and equipment			X	X	X	X	X
8	OSHA instruction - Inspection and citation guidance for roadway and highway construction work zones		X		X			X

Ref.	Title	Worker Training, Safety orientation for work zone workers	Traffic Control Plans and worker safety planning	Inspecting the constructio n work	Flagger operation and qualifications	Warning system for mobile equipment (mobile cranes, excavators, etc.)	Emergency Planning and Response	Disabilities Act in Work Zones	First Aid and medical Service
1	ODOT-2016 WorkZoneFactSheet								
2	2011_Oregon Temporary Traffic Control Handbook (For operations of three days or less)								
3	Intersection Safety - A manual for local rural road owners								
4	Roadway Departure Safety - A manual for local rural road owners								
5	Road safety information analysis - A manual for local rural road owners		X						
6	OSHA - Highway work zones and signs, signals, and barricades	X	X						
7	Building safer highway work zones. Measures to prevent worker injuries from vehicles and equipment	X	X						
8	OSHA instruction - Inspection and citation guidance for roadway and highway construction work zones	X		X					

Ref.	Title	Role and Responsibilities for workers, supervisors, etc. on the road	Accident Investigation after it happens	Let your supervisor know where you are going and when you will return	Ways to park, use, and place your vehicle to the site	Do not work alone, work with someone else. Especially for the first time.	Be aware of the blind spot for mobile equipment	Stay alert the entire day while working at the work zone	Survey Questions about work zone safety
1	ODOT-2016 WorkZoneFactSheet								
2	2011_Oregon Temporary Traffic Control Handbook (For operations of three days or less)								
3	Intersection Safety - A manual for local rural road owners								
4	Roadway Departure Safety - A manual for local rural road owners								
5	Road safety information analysis - A manual for local rural road owners								
6	OSHA - Highway work zones and signs, signals, and barricades								
7	Building safer highway work zones. Measures to prevent worker injuries from vehicles and equipment								
8	OSHA instruction - Inspection and citation guidance for roadway and highway construction work zones								

Ref.	Title	Link	Format	Expect the unexpected. Assume drivers don't see you	Beware of complacency - in yourself and coworkers	Avoid having your back to traffic or use a Spotter to watch your back for you	Wearing ANSI Class 3 high visibility safety garments, at least Class 2 (High-visibility safety apparel)
9	Manual on Uniform traffic control devices for streets and highways -2009 edition	http://mutcd.fhwa.dot.gov/pdfs/2009r1r2/mutcd2009r1r2edition.pdf	Publication				
10	Construction Safety Council, Hillside, IL - Work zone Hazards Awareness Workbook	https://www.osha.gov/dte/grant_materials/fy08/sh-17795-08/workzone_hazards_awareness_english.pdf	Workbook				X
11	ATSSA - Work Zone safety grant	http://www.atssa.com/WorkZoneSafetyGrant#Videos_Grant	Video				X
12	ATSSA - Guidance Documents	http://www.atssa.com/WorkZoneSafetyGrant/GuidanceDocs	Online Source				X
13	OSU Safety (SAF) Manual	http://fa.oregonstate.edu/saf-manual	Online Source				
14	Chemeketa Community College - Flagger Training	http://www.chemeketa.edu/busprofession/ccbi/customizedtraining/flagger.html	Online Source				
15	Environmental Health and Safety - Roadside Worker Safety	http://www.bu.edu/ehs/files/2012/02/Roadside-Worker-Safety-clean-10.11.pdf	Handbook				X

16	WSDOT - Roadside Safety	http://www.wsdot.wa.gov/publications/manuals/fulltext/M25-30/310.pdf	Handbook				
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Ref.	Title	Do Not use personal electronics while operating equipment	When you need electronics for your job, remember to look up often and in alternating directions	Do Not use electronics while flagging	Practice working with any electronic devices you need to use before getting on the jobsite	Have devices properly mounted instead of trying to hold them	Only use personal electronics in approved safe zones or during breaks
9	Manual on Uniform traffic control devices for streets and highways -2009 edition						
10	Construction Safety Council, Hillside, IL - Work zone Hazards Awareness Workbook						
11	ATSSA - Work Zone safety grant						
12	ATSSA - Guidance Documents						
13	OSU Safety (SAF) Manual						
14	Chemeketa Community College - Flagger Training						
15	Environmental Health and Safety - Roadside Worker Safety						
16	WSDOT - Roadside Safety						

Ref.	Title	Take personal cellphone in case of emergency	Be aware of the surroundings when using handheld devices	If you need longer focus, have a spotter next to you to watch for risks	Be sure to get two full nights of sleep (7 hours each) before working the night shift	Long naps (2hours) in the mid-afternoon prior to the night shift help reduce sleep debts	Best naps are 10-12 minutes long. Perfect for during lunch breaks
9	Manual on Uniform traffic control devices for streets and highways -2009 edition						
10	Construction Safety Council, Hillside, IL - Work zone Hazards Awareness Workbook		X	X			
11	ATSSA - Work Zone safety grant						
12	ATSSA - Guidance Documents						
13	OSU Safety (SAF) Manual						
14	Chemeketa Community College - Flagger Training						
15	Environmental Health and Safety - Roadside Worker Safety						
16	WSDOT - Roadside Safety						

Ref.	Title	If intermittent day and night work shifts are required, establish a 4-hour anchor sleep time each 24 hour period and supplement with naps	Make exercise/stretching part of the daily routine	Stay hydrated with water	Watch for signs of fatigue in others	Report near misses and unsafe behavior of co-worker to a supervisor	Work zone Infographic study
9	Manual on Uniform traffic control devices for streets and highways -2009 edition						X
10	Construction Safety Council, Hillside, IL - Work zone Hazards Awareness Workbook						X
11	ATSSA - Work Zone safety grant						
12	ATSSA - Guidance Documents						X
13	OSU Safety (SAF) Manual					X	
14	Chemeketa Community College - Flagger Training						
15	Environmental Health and Safety - Roadside Worker Safety						
16	WSDOT - Roadside Safety						

Ref.	Title	Do not control traffic with a spotter. A spotter is not a flagger.	Work Zone Components	Sight and Device Spacing and placement	Flagging and other Traffic Control Measures (TCM)	Case studies and experienced story telling	Safety information/statistics/ data collection and analysis	Work zone law and regulation enforcement
9	Manual on Uniform traffic control devices for streets and highways -2009 edition			X				
10	Construction Safety Council, Hillside, IL - Work zone Hazards Awareness Workbook	X	X	X	X			
11	ATSSA - Work Zone safety grant							
12	ATSSA - Guidance Documents				X			
13	OSU Safety (SAF) Manual		X					X
14	Chemeketa Community College - Flagger Training				X			
15	Environmental Health and Safety - Roadside Worker Safety		X	X	X			X
16	WSDOT - Roadside Safety			X				X

Ref.	Title	Worker Training, Safety orientation for work zone workers	Traffic Control Plans and worker safety planning	Inspecting the constructio n work	Flagger operation and qualifications	Warning system for mobile equipment (mobile cranes, excavators, etc.)	Emergency Planning and Response	Disabilities Act in Work Zones	First Aid and medical Service
9	Manual on Uniform traffic control devices for streets and highways -2009 edition								
10	Construction Safety Council, Hillside, IL - Work zone Hazards Awareness Workbook	X	X	X	X	X	X		
11	ATSSA - Work Zone safety grant	X			X				
12	ATSSA - Guidance Documents	X	X		X				
13	OSU Safety (SAF) Manual								X
14	Chemeketa Community College - Flagger Training				X				
15	Environmental Health and Safety - Roadside Worker Safety	X	X						
16	WSDOT - Roadside Safety								

Ref.	Title	Role and Responsibilities for workers, supervisors, etc. on the road	Accident Investigation after it happens	Let your supervisor know where you are going and when you will return	Ways to park, use, and place your vehicle to the site	Do not work alone, work with someone else. Especially for the first time.	Be aware of the blind spot for mobile equipment	Stay alert the entire day while working at the work zone	Survey Questions about work zone safety
9	Manual on Uniform traffic control devices for streets and highways -2009 edition								
10	Construction Safety Council, Hillside, IL - Work zone Hazards Awareness Workbook								
11	ATSSA - Work Zone safety grant								
12	ATSSA - Guidance Documents								
13	OSU Safety (SAF) Manual	X							
14	Chemeketa Community College - Flagger Training								
15	Environmental Health and Safety - Roadside Worker Safety	X							
16	WSDOT - Roadside Safety								

Ref.	Title	Link	Format	Expect the unexpected. Assume drivers don't see you	Beware of complacency - in yourself and coworkers	Avoid having your back to traffic or use a Spotter to watch your back for you	Waring ANSI Class 3 high visibility safety garments, at least Class 2 (High-visibility safety apparel)
17	OregonDOT - It Can Be a Dangerous Job	https://www.youtube.com/watch?v=yEGkcseNmqA	Video	X			
18	Purdue University - Student Roadside Safety Training *	https://www.youtube.com/watch?v=cOmh_8aiud4	Video	X	X	X	X
19	Norton Construction - Norton Road Construction Work Zone Safety	https://www.youtube.com/watch?v=0QBxt1BJwj0	Video			X	X
20	Work Zone Safety Traffic Control Devices	https://www.youtube.com/watch?v=ZWBQHpCfvEo	Video				
21	PublicResourceOrg - One Step from Death	https://www.youtube.com/watch?v=Lx53sAiZLeM	Video	X	X	X	X
22	TowingTV - Roadside Accidents	https://www.youtube.com/watch?v=mqqZre9Xxpw	Video	X			
23	NYSDOT - A Family's Grief - Your Car is Like a Weapon	https://www.youtube.com/watch?v=kHfX5ia74qY	Video	X			
24	Roadworker Safety - Silence is Consent (Part 1 and Part 2)	https://www.youtube.com/watch?v=oAvrFYkP3P0	Video		X		X
25	Work zone safety News - TDOT workers	https://www.youtube.com/watch?v=tQ_HONQaAAQ	Video	X			
26	Stay Alert Stay Alive - Work Zone Safety 2012	https://www.youtube.com/watch?v=Xk1yTLj02vw	Video	X			
27	Flagging - Safety Is In Your Hands	https://www.youtube.com/watch?v=3OC1As3jv-s	Video	X		X	X

Ref.	Title	Do Not use personal electronics while operating equipment	When you need electronics for your job, remember to look up often and in alternating directions	Do Not use electronics while flagging	Practice working with any electronic devices you need to use before getting on the jobsite	Have devices properly mounted instead of trying to hold them	Only use personal electronics in approved safe zones or during breaks
17	OregonDOT - It Can Be a Dangerous Job						
18	Purdue University - Student Roadside Safety Training *						
19	Norton Construction - Norton Road Construction Work Zone Safety						
20	Work Zone Safety Traffic Control Devices						
21	PublicResourceOrg - One Step from Death		X				X
22	TowingTV - Roadside Accidents						
23	NYSDOT - A Family's Grief - Your Car is Like a Weapon						
24	Roadworker Safety - Silence is Consent (Part 1 and Part 2)						
25	Work zone safety News - TDOT workers						
26	Stay Alert Stay Alive - Work Zone Safety 2012						
27	Flagging - Safety Is In Your Hands			X			

Ref.	Title	Take personal cellphone in case of emergency	Be aware of the surroundings when using handheld devices	If you need longer focus, have a spotter next to you to watch for risks	Be sure to get two full nights of sleep (7 hours each) before working the night shift	Long naps (2hours) in the mid-afternoon prior to the night shift help reduce sleep debts	Best naps are 10-12 minutes long. Perfect for during lunch breaks
17	OregonDOT - It Can Be a Dangerous Job		X				
18	Purdue University - Student Roadside Safety Training *	X	X	X			
19	Norton Construction - Norton Road Construction Work Zone Safety			X			
20	Work Zone Safety Traffic Control Devices						
21	PublicResourceOrg - One Step from Death						
22	TowingTV - Roadside Accidents						
23	NYSDOT - A Family's Grief - Your Car is Like a Weapon						
24	Roadworker Safety - Silence is Consent (Part 1 and Part 2)						
25	Work zone safety News - TDOT workers						
26	Stay Alert Stay Alive - Work Zone Safety 2012						
27	Flagging - Safety Is In Your Hands						

Ref.	Title	If intermittent day and night work shifts are required, establish a 4-hour anchor sleep time each 24 hour period and supplement with naps	Make exercise/stretching part of the daily routine	Stay hydrated with water	Watch for signs of fatigue in others	Report near misses and unsafe behavior of co-worker to a supervisor	Work zone Infographic study
17	OregonDOT - It Can Be a Dangerous Job						X
18	Purdue University - Student Roadside Safety Training *						X
19	Norton Construction - Norton Road Construction Work Zone Safety						
20	Work Zone Safety Traffic Control Devices						X
21	PublicResourceOrg - One Step from Death						
22	TowingTV - Roadside Accidents						
23	NYSDOT - A Family's Grief - Your Car is Like a Weapon						
24	Roadworker Safety - Silence is Consent (Part 1 and Part 2)					X	
25	Work zone safety News - TDOT workers						
26	Stay Alert Stay Alive - Work Zone Safety 2012						
27	Flagging - Safety Is In Your Hands						X

Ref.	Title	Do not control traffic with a spotter. A spotter is not a flagger.	Work Zone Components	Sight and Device Spacing and placement	Flagging and other Traffic Control Measures (TCM)	Case studies and experienced story telling	Safety information/statistics/ data collection and analysis	Work zone law and regulation enforcement
17	OregonDOT - It Can Be a Dangerous Job					X		
18	Purdue University - Student Roadside Safety Training *		X	X		X		
19	Norton Construction - Norton Road Construction Work Zone Safety							
20	Work Zone Safety Traffic Control Devices		X	X				
21	PublicResourceOrg - One Step from Death					X		
22	TowingTV - Roadside Accidents					X		
23	NYS DOT - A Family's Grief - Your Car is Like a Weapon					X		
24	Roadworker Safety - Silence is Consent (Part 1 and Part 2)					X	X	
25	Work zone safety News - TDOT workers					X		
26	Stay Alert Stay Alive - Work Zone Safety 2012						X	
27	Flagging - Safety Is In Your Hands	X			X			X

Ref.	Title	Worker Training, Safety orientation for work zone workers	Traffic Control Plans and worker safety planning	Inspecting the construction work	Flagger operation and qualifications	Warning system for mobile equipment (mobile cranes, excavators, etc.)	Emergency Planning and Response	Disabilities Act in Work Zones	First Aid and medical Service
17	OregonDOT - It Can Be a Dangerous Job						X		
18	Purdue University - Student Roadside Safety Training *	X	X	X					
19	Norton Construction - Norton Road Construction Work Zone Safety						X		
20	Work Zone Safety Traffic Control Devices								
21	PublicResourceOrg - One Step from Death								
22	TowingTV - Roadside Accidents								
23	NYS DOT - A Family's Grief - Your Car is Like a Weapon		X						
24	Roadworker Safety - Silence is Consent (Part 1 and Part 2)								
25	Work zone safety News - TDOT workers		X						
26	Stay Alert Stay Alive - Work Zone Safety 2012		X						
27	Flagging - Safety Is In Your Hands		X						

Ref.	Title	Role and Responsibilities for workers, supervisors, etc. on the road	Accident Investigation after it happens	Let your supervisor know where you are going and when you will return	Ways to park, use, and place your vehicle to the site	Do not work alone, work with someone else. Especially for the first time.	Be aware of the blind spot for mobile equipment	Stay alert the entire day while working at the work zone	Survey Questions about work zone safety
17	OregonDOT - It Can Be a Dangerous Job		X						
18	Purdue University - Student Roadside Safety Training *			X	X	X			
19	Norton Construction - Norton Road Construction Work Zone Safety				X	X	X		
20	Work Zone Safety Traffic Control Devices								
21	PublicResourceOrg - One Step from Death						X	X	
22	TowingTV - Roadside Accidents								
23	NYSDOT - A Family's Grief - Your Car is Like a Weapon								
24	Roadworker Safety - Silence is Consent (Part 1 and Part 2)								
25	Work zone safety News - TDOT workers								
26	Stay Alert Stay Alive - Work Zone Safety 2012								
27	Flagging - Safety Is In Your Hands						X		

Ref.	Title	Link	Format	Expect the unexpected. Assume drivers don't see you	Beware of complacency - in yourself and coworkers	Avoid having your back to traffic or use a Spotter to watch your back for you	Waring ANSI Class 3 high visibility safety garments, at least Class 2 (High-visibility safety apparel)
28	USDOT - Worker Safety	http://www.ops.fhwa.dot.gov/Wz/workersafety/index.htm	Online Source				
29	WisconsinDOT - Work zone safety	http://wisconsin.dot.gov/Pages/safety/education/workzone/default.aspx	Online Source	X			
30	OSHA Fact Sheet	https://www.osha.gov/OshDoc/data/HurricaneFacts/workzone_traffic_safety.pdf	Handbook				X
31	IndianaDOT - Work Zone Traffic Control Guidelines 2013	http://www.in.gov/indot/files/WorkZoneTCH.pdf	Handbook				
32	Vehicle Backing Safety Factsheet	http://www.tdi.texas.gov/pubs/videoresource/fsvehiclebackin.pdf	Handbook		X		
33	Drive Sober, The Way to Go. Transportation Safety - ODOT	...	Brochure				
34	Slow Down. The way to go	http://www.oregon.gov/ODOT/TS/docs/Enforcement/SpeedBro.pdf	Brochure		X		
35	Fines Double 24/7. Workers or not	http://www.oregon.gov/ODOT/TS/docs/Workzone/330453_Fines_Double_24-7_737-3527_04-2014.pdf	Brochure	X	X		
36	Slow Down - Follow the signs to safety	http://www.oregon.gov/ODOT/TS/docs/Workzone/WZ_brochure%20REV514.pdf	Brochure				
37	Don't be a fight risk - Buckle up	...	Brochure				
38	Oregon Winter Driving Guide	https://www.oregon.gov/ODOT/COMM/Pages/winterdriving.aspx	Online Source				

39	ODOT Safety Calendar	...	Calendar				
SUM				11	7	5	15

Ref.	Title	Do Not use personal electronics while operating equipment	When you need electronics for your job, remember to look up often and in alternating directions	Do Not use electronics while flagging	Practice working with any electronic devices you need to use before getting on the jobsite	Have devices properly mounted instead of trying to hold them	Only use personal electronics in approved safe zones or during breaks
28	USDOT - Worker Safety						
29	WisconsinDOT - Work zone safety						
30	OSHA Fact Sheet						
31	IndianaDOT - Work Zone Traffic Control Guidelines 2013						
32	Vehicle Backing Safety Factsheet						
33	Drive Sober, The Way to Go. Transportation Safety - ODOT						
34	Slow Down. The way to go						
35	Fines Double 24/7. Workers or not						
36	Slow Down - Follow the signs to safety						
37	Don't be a fight risk - Buckle up						
38	Oregon Winter Driving Guide						
39	ODOT Safety Calendar						
SUM		1	2	2	1	1	2

Ref.	Title	Take personal cellphone in case of emergency	Be aware of the surroundings when using handheld devices	If you need longer focus, have a spotter next to you to watch for risks	Be sure to get two full nights of sleep (7 hours each) before working the night shift	Long naps (2hours) in the mid-afternoon prior to the night shift help reduce sleep debts	Best naps are 10-12 minutes long. Perfect for during lunch breaks
28	USDOT - Worker Safety						
29	WisconsinDOT - Work zone safety						
30	OSHA Fact Sheet						
31	IndianaDOT - Work Zone Traffic Control Guidelines 2013						
32	Vehicle Backing Safety Factsheet						
33	Drive Sober, The Way to Go. Transportation Safety - ODOT						
34	Slow Down. The way to go						
35	Fines Double 24/7. Workers or not						
36	Slow Down - Follow the signs to safety						
37	Don't be a fight risk - Buckle up						
38	Oregon Winter Driving Guide						
39	ODOT Safety Calendar						
SUM		2	5	4	1	1	1

Ref.	Title	If intermittent day and night work shifts are required, establish a 4-hour anchor sleep time each 24 hour period and supplement with naps	Make exercise/stretching part of the daily routine	Stay hydrated with water	Watch for signs of fatigue in others	Report near misses and unsafe behavior of co-worker to a supervisor	Work zone Infographic study
28	USDOT - Worker Safety						
29	WisconsinDOT - Work zone safety						X
30	OSHA Fact Sheet						X
31	IndianaDOT - Work Zone Traffic Control Guidelines 2013						
32	Vehicle Backing Safety Factsheet						
33	Drive Sober, The Way to Go. Transportation Safety - ODOT						
34	Slow Down. The way to go						X
35	Fines Double 24/7. Workers or not						X
36	Slow Down - Follow the signs to safety						X
37	Don't be a fight risk - Buckle up						
38	Oregon Winter Driving Guide						X
39	ODOT Safety Calendar						
SUM		1	4	1	1	3	19

Ref.	Title	Do not control traffic with a spotter. A spotter is not a flagger.	Work Zone Components	Sight and Device Spacing and placement	Flagging and other Traffic Control Measures (TCM)	Case studies and experienced story telling	Safety information/statistics/ data collection and analysis	Work zone law and regulation enforcement
28	USDOT - Worker Safety						X	X
29	WisconsinDOT - Work zone safety							
30	OSHA Fact Sheet			X	X			
31	IndianaDOT - Work Zone Traffic Control Guidelines 2013		X	X	X			
32	Vehicle Backing Safety Factsheet					X		
33	Drive Sober, The Way to Go. Transportation Safety - ODOT						X	X
34	Slow Down. The way to go							
35	Fines Double 24/7. Workers or not							X
36	Slow Down - Follow the signs to safety							X
37	Don't be a fight risk - Buckle up							X
38	Oregon Winter Driving Guide						X	X
39	ODOT Safety Calendar							
SUM		3	8	12	10	11	7	14

Ref.	Title	Worker Training, Safety orientation for work zone workers	Traffic Control Plans and worker safety planning	Inspecting the construction work	Flagger operation and qualifications	Warning system for mobile equipment (mobile cranes, excavators, etc.)	Emergency Planning and Response	Disabilities Act in Work Zones	First Aid and medical Service
28	USDOT - Worker Safety	X	X						
29	WisconsinDOT - Work zone safety								
30	OSHA Fact Sheet		X						
31	IndianaDOT - Work Zone Traffic Control Guidelines 2013								
32	Vehicle Backing Safety Factsheet			X		X			
33	Drive Sober, The Way to Go. Transportation Safety - ODOT								
34	Slow Down. The way to go								
35	Fines Double 24/7. Workers or not								
36	Slow Down - Follow the signs to safety								
37	Don't be a fight risk - Buckle up								
38	Oregon Winter Driving Guide								
39	ODOT Safety Calendar						X		
SUM		9	13	4	5	2	4	1	1

Ref.	Title	Role and Responsibilities for workers, supervisors, etc. on the road	Accident Investigation after it happens	Let your supervisor know where you are going and when you will return	Ways to park, use, and place your vehicle to the site	Do not work alone, work with someone else. Especially for the first time.	Be aware of the blind spot for mobile equipment	Stay alert the entire day while working at the work zone	Survey Questions about work zone safety
28	USDOT - Worker Safety								
29	WisconsinDOT - Work zone safety								X
30	OSHA Fact Sheet								
31	IndianaDOT - Work Zone Traffic Control Guidelines 2013								
32	Vehicle Backing Safety Factsheet				X		X		
33	Drive Sober, The Way to Go. Transportation Safety - ODOT		X						
34	Slow Down. The way to go								
35	Fines Double 24/7. Workers or not								
36	Slow Down - Follow the signs to safety								
37	Don't be a fight risk - Buckle up								
38	Oregon Winter Driving Guide								
39	ODOT Safety Calendar								
SUM		2	2	1	3	2	4	1	1

APPENDIX B

B.0 IRB APPROVAL DETERMINATION



Human Research Protection Program
Institutional Review Board
Office of Research Integrity
8308 Kerr Administration Building, Corvallis, Oregon 97331-2140
(541) 737-8008
IRB@oregonstate.edu | <http://research.oregonstate.edu/irb>

DETERMINATION

Date of Notification	09/21/2016		
Study ID	7665		
Study Title	Student Worker Safety Guidelines in Roadside Applications and Work Zones		
Person Submitting Form	John Gambatese		
Principal Investigator	John Gambatese		
Study Team Members	Ding Liu		
Funding Source	Oregon Department of Transportation (ODOT)	Proposal #	N/A
PI on Grant or Contract	John Gambatese	Cayuse #	16-1869

DETERMINATION: NOT RESEARCH

It has been determined that your project, as submitted, **does not** meet the definition of research under the regulations set forth by the Department of Health and Human Services 45 CFR 46.

Note that amendments to this project may impact this determination.

The federal definitions and guidance used to make this determination may be found at the following link: [Research](#)

APPENDIX C

C.0 DOT SURVEY QUESTIONNAIRE (CONTRACTOR SURVEY QUESTIONNAIRE SIMILAR)

Student Worker Safety Guidelines in Roadside Applications and Work Zones

Dear Participant,

We would like to thank you for taking the time to participate in this survey entitled "Student Worker Safety Guidelines in Roadside Applications and Work Zones."

Your responses to this survey and personal information provided will be kept confidential, used only for academic purposes related to the study, and will not be distributed to the public. All identifying information connecting respondents to their responses will be removed as part of the data collection process. Publications generated from the research study will not include any information that can be used to identify respondents.

If you have any questions about the survey, please contact the researchers listed below. If you have questions about your rights or welfare as a survey participant, please contact the Oregon State University Institutional Review Board (IRB) Office at 541-737-8008, or by email at IRB@oregonstate.edu.

Research Team:

Ding Liu, Civil and Construction Engineering, Oregon State University, 101 Kearney Hall, Corvallis, OR 97331; Cell-phone: (541) 979-7286; E-mail: liudi@oregonstate.edu

John Gambatese, Civil and Construction Engineering, Oregon State University, 101 Kearney Hall, Corvallis, OR 97331; Cell-phone: (541) 737-8913; E-mail: john.gambatese@oregonstate.edu

Acknowledgement:

By continuing the survey, I have read the above description of the research. If I had questions or would like additional information, I contacted the researchers and had all of my questions answered to my satisfaction. I agree to voluntarily participate in this research. By answering the survey questions and responding to this survey, I affirm that I have read the above information, agree to participate in the research, and am at least 18 years of age or older.

Survey Questions for DOTs

Demographic Information

Q1. What type of organization do you work for?

- Federal Highway Administration
- State DOT; please specify the state: _____
- Others, please specify: _____

Q2. What is your position/title?

- Project Manager
- Project Engineer
- Safety Manager
- Superintendent
- Maintenance
- Research manager
- Others, please identify: _____

Q3. How many years of experience do you have in the construction industry?

- Less than 2
- 2 ~ 5
- 6 ~ 10
- 10 ~ 20
- More than 20

Key Terms Definition

1. **Student Workers** – In this survey, student workers/researchers refer to the students who are hired by their PI or by the school. Student interns hired by contractors and DOTs are not the target groups.
2. **Roadway work site** – refers to any student workers' possible activities happened on the roadway work site. Those activities include but not limited to work zone activities, roadside data collections, roadside sample testing, etc.

Student Worker Information

Q4. Have you ever had student interns/observers/researchers working on your roadway work site?

- Yes
- No
- I am not sure

Q4a. If yes, where and what were they doing? Please select all that apply.

- Roadway work zone activities
- Roadside data collections, such as counting cars, measuring speed, etc.
- Roadside sample testing, such as road material testing, soil sampling, etc.
- Other: _____

Student Worker Safety Concerns

Q5. Over the span of last 4 years, how many student workers/researchers were on your roadway work site?

Q6. How well do students perform in terms of safety while working on roadway work sites?

- Very poor
- Below average
- Average
- Good
- Extremely well

Q6a. Among all different situations, what situation do you think student workers/researchers perform well?

Q6b. Among all different situations, what situation do you think student workers/researchers perform not well?

Q7. How do student workers compare to other workers in terms of safety in construction work zones?

- Much worse
- A little worse
- About the same
- A little better
- Much better

Q8. With regards to safety, what concerns you most when you see student workers working in construction work zones? Please select all that apply.

- Not paying attention
- Fatigue
- Do not know the safety hazards
- Do not care about safety
- Other (please specify): _____

Safety Training Information

Q9. Do you think it is necessary for student workers to receive safety training before they enter a construction work zone?

- Yes
- No
- I am not sure

Q10. What format for the safety training do you think is most effective?

- a. Written manual
- b. Videos
- c. Online interactive training module
- d. Short guideline / tip sheet
- e. In-person training
- f. Combination training, please specify: _____
- g. Others, please list: _____

Q11. How much safety training do you think a student should receive before entering a work zone?

- Half an hour
- One hour
- One day
- One week
- Other, please identify: _____

Q12. How often do think student workers should receive safety training?

- Daily
- Weekly
- Monthly
- Yearly
- Others, please identify: _____

Q13. For student workers, what content do you think should be included in their safety training?

- Personal protective equipment
- Warning signs and signals
- Flagging
- Working around equipment
- Others, please identify: _____

Q14. Do you think there should be some specific safety requirements for student workers regarding when and where a personal cell phone may be used while on a construction site?

- Yes
- No
- I am not sure

Q15. Do you think student workers should receive different or additional training compared to regular, full-time workers?

- Yes
- No
- I am not sure

Q15a. If yes, please indicate the different or additional training that students should receive.

Specific Safety Requirements for Student Workers

Q16. Do you think there should be some specific safety requirements for student workers regarding getting enough rest for the work day and fatigue when on a construction site?

- Yes
- No
- I am not sure

Q17. How do you suggest that safety risks for student workers should be prevented and eliminated on-site?

Q18. Do you think it is helpful to have an experienced worker share their experiences and safety knowledge with new student workers before the students enter the construction work zone?

- Yes
- No
- I am not sure

Q19. Do you have systems for students to report near misses?

- Yes, please specify
- No
- Not sure

Final Summarized Question

Q20. Please share any other suggestions that you may have regarding the safety of student workers in construction work zones.

If you have any questions or want to learn more about our research, please feel free to reach us at: liudi@oregonstate.edu or john.gambatese@oregonstate.edu

Thanks again!